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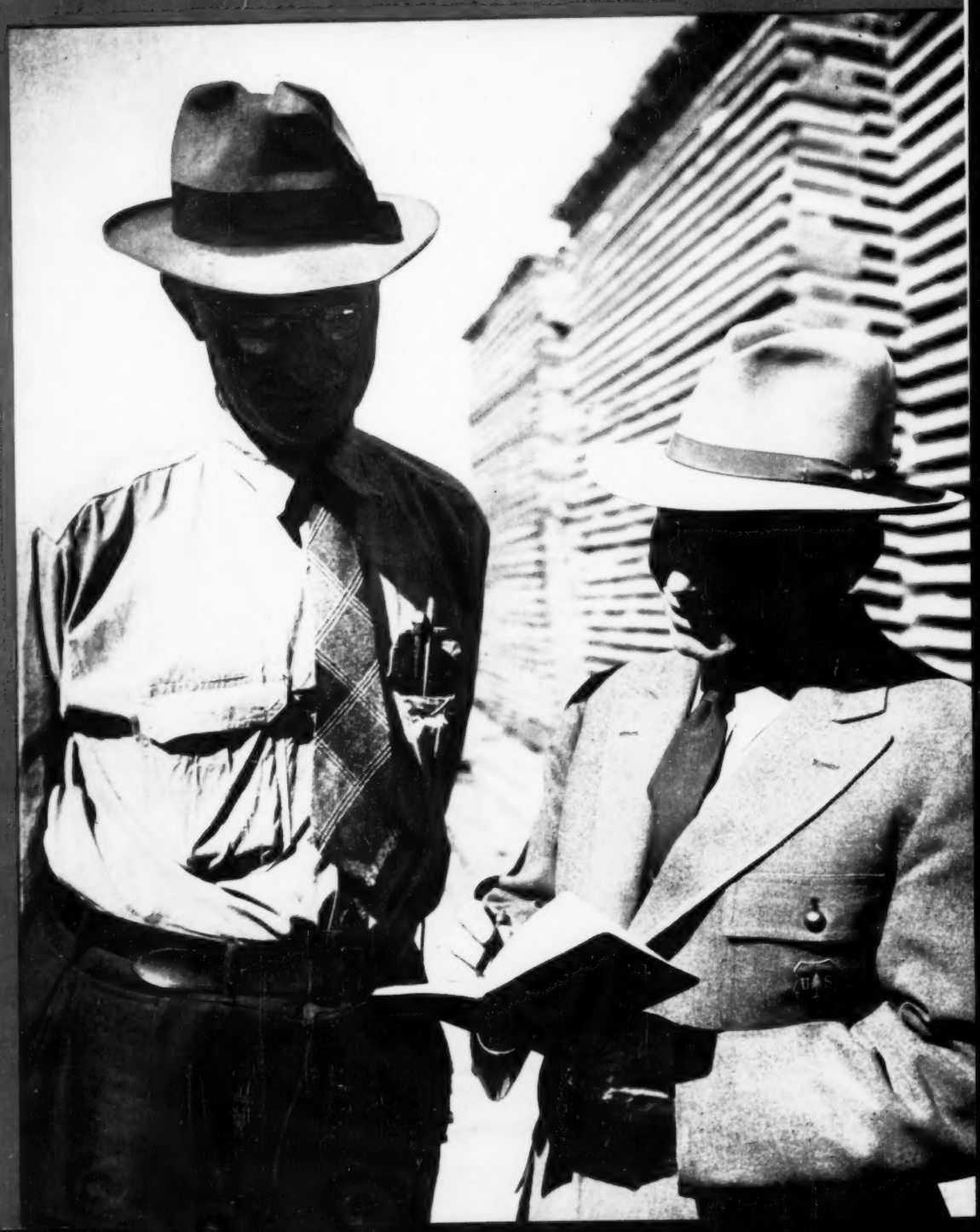

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Journal of Forestry

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Qualifications of the District Ranger Position

Junior Staff
Forest Service, U. S. Department of Agriculture, Washington, D. C.[1]

The duties and responsibilities of the district ranger in the national forest organization have undergone a marked transition during the past decade. He was largely a custodian in the early days of the Forest Service, but his present importance as a basic resource manager is increasingly evident. Present-day evaluation of candidates for the position involves a careful appraisal of background, education, training, and experience in the light of this trend.

TO HELP MEASURE the caliber of the position of district ranger and to facilitate its classification, the chief of the Forest Service designated a group of individuals to appraise and describe the necessary qualifications. Special attention was directed to the intangible aspects required in contrast to the more tangible ones which are readily recognized. The group selected to make this study was composed of staff assistants in the Washington Office who had recently served as rangers and supervisors or in other responsible resource management positions. Their backgrounds included a broad cross section of forest regions and different resource interests.

This article is the result of assembling and coordinating the statements and opinions of the nine members of the group. The following joint appraisal of less tangible aspects of the district ranger position, made by foresters closely associated with it, may be of value to educators and prospective career foresters. No effort is made to discuss here the more well known, tangible, classes of work for which the ranger is responsible.

Qualifications

The ranger is more than a forestry technician. He is responsible for the wise handling of the timber, range, water, wildlife, and recreation resources of his district. In the Forest Service organization he is a professional forester who is in continuous contact with the land, its problems, and the people closely associated with it.

A ranger has three broad fields of responsibility, which may be briefly defined as follows:

Field I.—Understand and be able to recognize what constitutes favorable forest and associated resource conditions and the factors which affect such conditions. These factors may be ecological or social or both.

Field II.—Measure such factors affecting forest and associated resource conditions, either in terms of specific units or by comparison with other areas, and interpret these measurements in terms of cause and effect.

Field III.—Translate into action, within approved Forest Service policy, the results of such measurements and observations.

Descriptions of the ranger's duties and responsibilities generally emphasize the third phase of the job, since activities associated with action may be described easily in terms of volume and frequency. However, a ranger whose capabilities are limited to this narrow field and who is weak or lacking in the abilities described in I and II cannot be considered fully capable of meeting the responsibilities of an average ranger district. His capacity would then appear to be semiprofessional rather than professional.

Examples of Qualifications

Specific examples of professional qualifications for the ranger position and their application to administrative responsibilities are given below. These examples refer to the more intangible abilities and duties that relate to the above-mentioned three broad fields of responsibility.

Field I

1. Knowledge of systematic botany, which enables the ranger to identify hundreds of plant species that make up the complex of vegetation found on national forests. Such knowledge is fundamental to observing and interpreting forest conditions.

2. Understanding of plant ecology as a basis for management of both woodlands and grasslands. A knowledge of climate, geology, and soils is fundamental in this regard. An understanding of ecology is necessary in appraising or measuring such factors as site, site index, planting requirements, growth calculations, forage trends, watershed trends, and the like.

3. Some knowledge of entomology, pathology, zoology, meteorology and associated sciences provides the breadth of understanding which

[1] Bert Lexen, *chairman*, Forest Management Research; K. D. Flock, Personnel Management; M. B. Bruce, Timber Management; C. T. Sullivan, Engineering; E. T. Williams, Forest Economics; K. W. Parker, Range Management; G. J. Gray, Operations; W. J. Stahl, Cooperative Forest Protection; B. L. Rasmussen, Fire Control.

permits early recognition of important changes in resource conditions, such as disease or insect infestations, fire danger, unbalance in the wildlife population, deterioration or improvement of streamflow and rangeland.

4. Knowledge of forest economics is an important qualification that enables exercise of considered judgment in the allocation of expenditures for national forest operation, protection, and management on the basis of "best first," or getting the greatest value per dollar spent. Also essential is a knowledge of growth and drain relationship, timber values, markets, stumpage prices, and local wood-using industries.

5. Familiarity with watershed values and their importance to the local and general economy of the region. The ranger must be trained to recognize early indications of factors adversely affecting stream flow.

6. Ability to recognize and evaluate the social impact of forest resource development, use, or deterioration. The ranger must be a leader in his community in obtaining desirable socio-economic conditions as they are affected by the forest and its resources.

7. Knowledge of farm and ranch operations. This is a requisite to managing national forest range use as an integral part of permittee ranch and farm operations.

8. Knowledge of the recreational needs and habits of local people, and others as well, in order to intelligently guide and develop recreational improvement and use.

Field II

1. Use of aerial photography and interpretation for forest and range measurements. The modern ranger must have a working knowledge of such techniques and must keep in touch with new developments in this field.

2. Knowledge of meteorology and hydrology, which enables him to measure and appraise watershed conditions where water is essential for domestic use, power, and irrigation, and to prescribe proper treatment for unsatisfactory situations.

3. Modern sampling techniques permit savings in time in all fields of endeavor including the measurement of both basic factors and end products. A ranger must understand the value of such techniques and their application.

4. Basic training in surveying and forest engineering, including a working knowledge of public land office procedures, land records, etc. Such ability is needed in making quantitative determinations and in handling custodial problems.

5. Knowledge of sawmilling practice, sawmill products and their end use, lumber association grades and rules, and other timber utilization practices. All these are requisite to satisfactory sale appraisals, studies of utilization requirements, overrun determinations, grade recovery studies, and the like.

6. Knowledge of the principles and methods of preventing, detecting and suppressing forest fires. He must understand the relationship of fuel, topography, moisture, and air movement to fire behavior and interpret when a combination of these factors may result in serious fires.

Field III

1. Competence in the field of public relations, and the ability to deal capably with people. Land management cannot be disassociated from people.

2. Ability to write and speak clearly and convincingly is essential to getting action programs into effect.

3. Skill in supervising and developing employees, whose duties often involve difficult and unusual living conditions as well as strenuous activities.

4. Knowledge of the principles and application of business management. The business which the ranger conducts is often the largest in his community.

Conclusion

The listing of more or less intangible qualifications and abilities given here is not necessarily complete. The frequency of need and application of each of these requirements varies in different sections of the country. However, the administration of many ranger districts requires the use of a large number of such abilities, if not all of them. Districts of this type call for a high level of ability and performance.

❦❦❦

Forest Research in Colleges and Universities Offering Forestry Education

R. H. Westveld
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As the practice of forestry becomes a reality on a larger area of land each year, adequate forest research programs are a necessity. Better forestland management and more effective use of wood depend upon research. Since research in forestry and wood technology is of relatively recent origin and since the results from research, at least in timber production can not be attained as quickly as from annual or perennial agricultural crops, it is important that full advantage be taken of all the facilities that are available for the development of research in these fields. One of the really great potentials for the expansion of forest research is in the colleges and universities which offer education in forestry. Forest research developed slowly at these institutions until recently, but has made substantial, and in a few instances, spectacular progress since World War II. Most of these schools are uniquely equipped to do research in forestry. They have personnel, many of whom are well trained and interested in doing research. They have equipment, which often does only part-time duty in teaching, and which can be used for research; and they own forest lands, which are an important asset in a research program. The forestry personnel at colleges and universities has access to specialists in many other fields such as chemistry, physics, biology, geology, soils, engineering, and economics, who can often contribute to the solution of forestry and wood technology problems. Some of the schools have been able to build fine research programs on this broad foundation, but most of them have not been able to capitalize to the fullest extent on their advantageous position because of inadequate financial support. However, as their potentialities become more generally recognized, the educational institutions should get adequate support and they should become a more vital force in research in forestry and wood technology.

It is the purpose of this paper to show how forest research has developed in the colleges and universities offering education in forestry; to show what progress has been made; and to indicate the need and opportunities for vast expansion of the research programs in forestry and wood technology. The statistics which are given are based on replies to a questionnaire which was sent to 61 departments at 55 colleges and universities. Fifty-three of the schools have some kind of educational program in forestry; three schools have engineering departments which have done or are doing some type of research in wood utilization. At 5 institutions having educational programs in forestry, wood utilization research is handled in engineering departments or research divisions outside the forestry departments. Replies were received from 55 of the 61 departments, representing 50 institutions. Forty-four departments at forty-one institutions have research programs. One other institution that did not answer the questionnaire is known to have a research program.

Development of Research Program

The first organized research in forestry at an educational institution apparently began in 1899. Progress was slow during the next 25 years and did not gain momentum until after World War II. Table 1 shows how research developed at the 40 schools at which the date of the initiation of research is known.

Table 1.—Development of Research at 40 Schools Where Date of Initiation Is Known

Date research initiated	Number of departments	Percent of total
Prior to 1915	9	22.5
1925-1934	8	20.0
1935-1944	8	20.0
1945-1951	15	37.5

One accredited forestry school that is known to have a research program is not included above because it did not respond to the questionnaire. Five of the departments do only wood-utilization research.

Although the agricultural experiment stations spent $7,660,571 for research during the fiscal year 1920-21 (*2*), only four of them were doing forest research at that time. Possibly the absence of acts of congress that made specific provision for forest research at the agricultural experiment stations at that time, and even later, worked to the disadvantage of forestry in these earlier years. Certainly the five acts of Congress which provided funds for agricultural research at the land grant institutions have been a stimulant to the experiment station programs which for the fiscal year 1949-50, with federal appropriations of $11,969,216, spent $63,671,668 (*3*). The initiation of forest research at 15 institutions (eleven land grant colleges) between 1945 and 1951 is evidence that the need for forest research is now rather generally recognized. The development of forest research at the accredited forestry schools is especially noteworthy. All have research programs. In 1934-1935, only seven of the fourteen accredited schools had research budgets, although at six other schools, faculty members were engaged in research, apparently financed by teaching funds (*1*). Four of the schools whose research budgets were published had a combined budget of $17,551 and another school had temporary E.C.W. funds of $27,600 for forest research. None of the six schools which failed to be accredited at that time were doing research.

Budgets for Forest Research

Although factual data on research budgets prior to 1940 were not obtained, it is evident from fragmentary information that funds devoted to research were small. The forest research budget

TABLE 2.—FOREST RESEARCH BUDGETS DURING THREE FISCAL YEARS

Type of department	1940-41 Dollars	1947-48 Dollars	1950-51[1] Dollars
Accredited Forestry Schools (25-24-24)[2]	204,458	502,252	803,938
Forestry Schools not accredited (11-7-4)	14,667	48,743	85,151
Other forestry departments (17-17-11)	31,400	124,267	180,241
Engineering departments or research institutes (8-7-5)[3]	6,000	79,260	130,380
Total	256,525	754,522	1,199,710

[1]While this article was being put into final form for publication, the author found upon inquiry that the total budget of these schools for the fiscal year 1952-53 was $1,542,590. However, 69% of the increase over 1950-51 occurred at one institution.

[2]The first figure represents the number of departments to which the questionnaire was sent, the second represents the number of replies received, and the third number represents the number of departments that had research programs in 1950-51.

[3]Includes departments doing wood utilization research administered by other than forestry departments, such as engineering experiment stations, departments of civil engineering or building construction, and research institutes. All of these are located at institutions that have forestry schools or departments, one of them at an institution that has an accredited forestry school.

probably did not pass the $100,000 mark until the late 30's. Since then funds available for forest research have increased sharply, although inflation exaggerates the increase in actual research work that can be done. Budgets for forest research by four categories of departments during three fiscal years are shown in Table 2.

The five-fold increase in funds for forest research between 1941 and 1951 indicates a great expansion in forest research at educational institutions. Even after taking inflation into account, the 1951 program probably is about two and one-half times as large as the 1941 program. This is not true, however, at all institutions. Substantial increases at a few institutions and the initiation of new programs at twenty-one institutions make the overall situation less encouraging. However, only four of the seventeen schools doing research in 1941 had less than twice as much funds in 1951 than in 1941. These four schools are probably doing no more and possibly less research in 1951 than in 1941. Based on the twenty-four schools which reported, the accredited forestry schools had 70 percent of the forest research budget for colleges and universities.

Land grant colleges did not expand their budgets for forest research between 1941 and 1951 quite as much as all educational institutions. Furthermore, although the proportion of the agricultural experiment stations' funds allocated to forest research increased sharply between 1941 and 1951, the total budgets of these stations rose proportionately more. These relationships are shown in Table 3 by expressing the 1948 and 1951 budgets as a percentage of the 1941 budget.

TABLE 3.—1948 AND 1951 BUDGETS AS A PERCENTAGE OF 1941 BUDGET

	Percentage of 1941 budget: 1948 budget	1951 budget
Forest research		
All institutions	305	479
35 land grant colleges	290	422
Portion of agricultural experiment station budget	116	163
Total agricultural experiment station budget	229	250
Federal funds in agricultural experiment station budget	128	174

In 1941, 1948, and 1951, the percentage of the agricultural experiment station budgets allotted to forest research was 0.86, 1.00, and 1.40, respectively. The annual budgets were $158,115, $409,715, and $605,547, respectively.

Although forestry has not fared as well as other fields of work on a national basis in the assignment of funds, exceptions do occur in individual states.

The 33 states with land grant institutions that do forest research have a forest area of 433,487,000 acres or 69 percent of the forest land area of the United States. Forest land constitutes 37 percent of the land area of these 33 states. Seemingly, forest research is not getting financial support commensurate with the importance of the forest resources of these states. At only 8 of the 19 accredited forestry schools at land grant colleges did the research budget for forestry in 1951 exceed the 1.40 percent of the agricultural experiment station budget, the highest being 4.5 percent. The forest research budget at four accredited schools was less than 0.5 percent of the agricultural experiment station budget.

The amount of funds available for forest research varies widely at different institutions, as shown in Table 4.

TABLE 4.—FUNDS AVAILABLE FOR FOREST RESEARCH

Size of budget	1940-1941	1947-1948	1950-1951
Accredited Schools			
None	9	2	0
$500-10,000	8	10	8
$10,001-20,000	5	4	6
$20,001-40,000	2	5	3
$40,001-60,000	0	2	5
Over $60,000	0	1	2
Non accredited Schools			
None	0	2	3
$500-10,000	0	1	2
$10,001-20,000	1	1	1
$20,001-40,000	0	0	0
$40,001-60,000	0	1	0
$60,001 and over	0	0	1
Other Forestry Departments and Other Categories			
None	17	11	8
$500-10,000	4	5	8
$10,001-20,000	1	3	1
$20,001-40,000	0	3	4
$40,001-60,000	0	1	3
Over $60,000	0	0	0

It is obvious that budgets are generally too small to provide for the development of an effective research program. Twenty-six of the forty-four departments doing research had budgets of less than $20,000 a year in 1950-51. Eleven schools—ten of them state-supported institutions—had budgets in excess of $40,000.

Complete information on the source of funds used for forest research could not be obtained. Therefore the total of funds for 1951 shown in Table 5 is $141,464 less than that given earlier.

Nearly 60 percent of the funds used for forest research are state funds. Although grants from other

TABLE 5.—TOTAL OF FUNDS FOR 1951

Source of funds	Dollars	Percent
Federal	74,364	7.0
State		
Funds from college budget	499,901	47.4
Grants from other state agencies	76,500	7.2
Other state funds	54,500	5.1
Private funds from college budget	240,258	22.7
Grants from industry	53,471	5.0
Grants from foundations	55,982	5.3
Other	3,270	0.3
Total	1,058,246	100.0

state agencies are in a few instances substantial, cooperation between the schools and the state agencies is on a limited scale. Only seven of the forty-four departments engaged in forest research get financial support from other state agencies. Grants from industry and from foundations are significant in the aggregate, but only a few schools enjoy such support. Although eleven schools receive grants from industry, one school receives nearly as much as the other ten combined. The average amount of the grants from industry of these ten schools is $2,762. Grants from foundations in 1951 were received by five schools, and one of these received nearly 87 percent of the total.

Use of Funds for Various Fields of Work

The amount of money spent on research in the five major fields of forestry during the fiscal year of 1951 by 42 of the 44 schools was as follows:

	Dollars	Percent
Silviculture	273,444	23.2
Management	248,048	21.1
Utilization	479,578	40.8
Economics	134,648	11.4
Protection	41,891	3.5
Total	1,177,609	100.0

The research efforts are directed chiefly in silviculture, management, and utilization, more than 85 percent of the funds being used for these three fields of work. It is worthy of note that more than one-fourth of the funds spent on utilization research — $130,225 to be exact—is spent in four institutions where the wood utilization research is administered outside of the forestry school or department.

Other State Forest Research

The schools were asked to report whether other state agencies such as state forest services or conservation departments were engaged in forest research. Of the thirty-six states in which colleges or universities are offering instruction in forestry, the reports suggested that fourteen had state agencies that were doing forest research. However, it was found that in only ten of these states, was forest research in progress, with a total expenditure in 1951 of $617,462. In two other states, state agencies spent $11,400 for forest research in 1951. In the seven states having the largest state-financed budgets for forest research (either college or university alone or combination of college or university and state agency) the amounts range from nearly $60,000 annually to nearly $300,000; and five exceeded $100,000. These amounts were in five cases supplemented by grants from industry or from foundations. It is apparent that too few states have achieved the type of forest research program that was envisioned by the Special Committee on Forest Research (1926)[1](*4*).

The land grant colleges, with their agricultural experiment stations, are well equipped and organized to take the leadership in assuming responsibility for forest research at the state level. Already 33 of the 40 institutions having both instruction and research in forestry are land grant colleges. That progress has been substantial is indicated by the increase from 17 to 40 in the number of institutions engaged in forest research between 1941 and 1951. The 31 land grant colleges whose forest research budgets are known spent $825,301 in 1951. This constituted approximately 69 percent of the money spent for forest research by schools giving instruction in forestry. Although good progress has been made on a national basis, several states with an important stake in forest land are doing little or nothing. An agricultural experiment station in a state with 58 percent of its land area in forests is spending nothing for forest research; neither is the state forest service doing any research. In three states having from 42 to 65 percent of their land area in forest, their land grant colleges each spent $2,000 or less for forest research in 1951. In one of these states, the state forest service spent $1000 in 1951. Evidently, these states are relying largely on the federal forest experiment stations to do research which they should be doing.

Only in seven states do the state agencies have significant forest research programs. In one state, nearly $300,000 was spent in 1950-51; in two states approximately $60,000 was spent; in two others, $40,000 to $50,000, was spent; and in two nearly $20,000 was spent. In two of the states, the research is limited to the field of protection. The remaining 5 states spent a total of $17,650 in 1950-51.

Developing More Effective State Forest Research Programs

Strengthening of the state programs in forest research is essential to progress in the management of forest land and more effective and profitable use of the products of the land. The strengthening and expansion of these programs could undoubtedly, in most cases, be done most effectively and economically through the state educational institutions. The major responsibility rests with the land grant colleges because thirty-eight of the schools offering instruction in forestry are units of such institutions. Research is a specialized job that can best be done by personnel trained specifically to do research. The forestry schools and departments al-

[1]The committee recommended a program for the states which averaged $40,000 to $62,500 annually for each of the 48 states. In terms of 1952 monetary values this would be approximately $80,000 to $125,000 annually for each state. Five states have achieved the minimum. Three of these states ranked first, second, and third, and the fourth ranked seventh, nationally, in income in 1949. All have large areas of forest land.

ready have a nucleus of such personnel, and other assets already described. The development of effective forest research units at the colleges and universities offering instruction in forestry will require a realistic understanding by agricultural experiment station directors and others who administer state research programs of the importance of forest resources and wood-using industries in their states. Furthermore, these institutions must secure maximum cooperation from other state agencies and with industry. Past history demonstrates that state forest services and conservation departments, with a few exceptions, have had no desire to engage in research. In most cases they probably would never have started any research if the land grant college had taken the initiative to set up a forest research program. It is reasonable to believe that these agencies in most of the states would welcome the opportunity of having their college or university take the leadership in forest research, and many could arrange to lend some financial support to the college program. Financial support from industry is equally important in developing an effective research program. At least one group of industries—those dependent on oak—have demonstrated their willingness to cooperate with state colleges. The Oak Wilt Research Committee, sponsored by various trade associations whose members are large users of oak, raised in excess of $50,000 annually during 1951 and 1952 and turned these funds over to the plant pathology departments of several state universities for research on oak wilt. The schools need such support in other fields of work.

If the land grant colleges and other educational institutions are to play an increasingly important role in forest research in the future, the administrators of the forestry schools and departments will have to press aggressively for increased funds. This will require full cooperation from the directors of research at these institutions. Friends of forestry, individually and through organized effort, can help in giving the members of the legislatures essential facts about the states' forest resources and wood-using industries. Supervisors of the schools' research programs can hope to gain support from other state agencies by including in their research programs projects on problems which the state agencies are anxious to have solved. Similarly, private industries are likely to support a forestry school's research program if some of the projects will eventually benefit them directly. The forestry schools and departments must make it their responsibility to expand their research programs in order that the states will more adequately assume a responsibility that the federal government has taken by default of the states. Private industry has an opportunity and a responsibility to share in such a development.

There is probably no formula for adequate financing of a state forest research program. Each state has its own situation and problems. In states where the forest land is predominantly in federal ownership, as in several of the western states, the federal forest experiment stations may minimize the need for state work. On the other hand, in states having a large portion of their forest lands in thousands of small ownerships, the need for a strong state program is acute since the individual owner cannot effectively do his own research. The situation is similar to that in agriculture. In any case, the area of land in private and state ownership, the value of the forest industries, the condition of the land and its potentialities, and the ability of the state to finance public services, as indicated by the state's wealth, are among the factors that will determine the scope of the state's research program.

Summary

State-financed forest research was late in getting under way and was not generally recognized as a state responsibility until after World War II. Since then, under the leadership of the forestry schools and departments at the colleges and universities, development of forest research has been substantial—44 educational institutions in 35 states had forest research programs in 1951. In three of the colleges, wood utilization research was being done outside of the forestry schools or departments. However, too many of the research programs are too small, in proportion to the importance of the forest resources in the state, to be effective. Only 11 schools had budgets of more than $40,000 in 1951. In 9 states the work of the schools was supplemented by that of the state forest service, and in 3 states where the schools had no research program, the state forest service was the sole research agency. Two of the state forest service programs were supported by budgets in 1951 of nearly $20,000, two were supported by budgets of $40,000 to $50,000, and two others were supported by budgets of $60,000 and one was supported by a budget of nearly $300,000. The others were token programs. Seven schools benefit from funds turned over to them by a state agency, usually the forest service or conservation department. In 1951 the amount of these grants was $76,600. The schools have benefitted to a lesser extent from grants from industry and from foundations, but again, most of the schools do not receive such support.

The research programs of the schools vary widely in their coverage of the various fields of forestry. Although a few schools have concentrated on one or two fields, most schools are doing work in three or four fields. Where funds are limited, the first approach seems most logical.

There appears to be a need for greater forest research effort by the states. The land grant colleges with their agricultural experiment stations, many of them already having substantial well-organized forest research programs, are the logical places for the concentration of forest research by the states. With the cooperation and support of state forest services and private industry, these schools are in a posi-

tion to expand their programs and assume the state's responsibility in forest research.

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Ground Control for Planimetric Base Maps

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GROUND CONTROL is essential for preparation of accurate base maps whether compiled from ground surveys or from aerial photographs. Since maps are continually used in the determination of distances, directions (bearings or azimuths), and areas, it is evident that scale should be more or less constant over the entire surface of the map and that objects on the map should be properly placed in relation to one another. With an increase in area, the difficulty and cost of meeting the requirements for an accurate base map also increase. The average forestry organization normally uses some existing map or prepares a base map by compiling and combining the results of various property line and/or road surveys (*1*). Seldom have these separate surveys been run with comparable accuracy or with standardized tapes. The errors in matching are often overcome by "fudging" or averaging the error. For many purposes such maps may be perfectly satisfactory, but, if accurate areas are desired for the computation of timber volumes or growth, it is necessary to have a better base map.

In the estimation of timber volumes and growth the problem becomes most acute. Since the end of World War II, the science of forest photogrammetry has taken great strides forward in evaluation of forest stands and in the use of photographic information in volume determinations. In actual practice, however, many foresters arrive at erroneous conclusions because so little stress has appeared in print on the necessity for accurate type or stand maps. The great advantage that photo-controlled ground cruises have over conventional ground cruises is absolute area control. There is no guessing as to the location of type or stand boundaries. With such area control, the forest population is effectively stratified and the ground sample can be distributed in the most efficient manner. When the average per acre volumes have been obtained for each class, they are applied to the corresponding class acreage obtained from the type map to arrive at the total volume for each class. Class volumes are added together to find the total volume of the whole area. The accuracy of these total volume data is thus largely dependent on the accuracy of the type map from which the acreages are obtained. The accuracy of the type map in turn depends on the ground control for the planimetric base map.

It has been often demonstrated that foresters do not fully appreciate this relationship in forest photogrammetry. Index mosaics have been used as base maps, radial line plots tied to no ground control have been constructed, and acreages have been taken directly from the contact prints. Such procedures lead to erroneous results and tend to discredit forest photogrammetric procedures. Thus it is useful to summarize some of the available methods of setting up ground control for base maps.

If a forestry organization desires to use aerial photographs in the preparation of a good base map over a fairly large area at a medium scale, there are really only two economically feasible ways by which the photographic images can be properly oriented in relation to one another and plotted to a more or less common scale. The first involves the use of a grid of General Land Office lines and corners. The second is to build the map on a radial line plot, which is controlled by surveyed control points.

Using a Grid of G.L.O. Lines and Corners

Where General Land Office resurveys have been made and where the lines and corners can be identified on the aerial photographs, it is occasionally possible to construct a system of such lines and corners in which the points lie in proper relation to one another. The photo details are then plotted on this base by matching property corners on the photographs with equivalent corners on the plot. The accuracy of this method depends on the accuracy of the G.L.O. resurvey and the precision with which corners

can be located on the photographs. A map developed through this procedure would agree with legal dimensions and acreages, which for volume purposes may or may not be desirable. This procedure is seldom applicable because of the scarcity of proven corners along with accurate courses and distances.

Procedure

1. Plot G.L.O. notes to scale on the map sheet and develop grid of lines and corners for entire area. Use township, section, quarter, and sixteenth corners. A complete breakdown plotted by actual survey data is desirable.

2. Go into the field and find as many of the above corners as possible and carefully identify them on the aerial photographs. Locate the points as closely as possible on the photos, prick with a needle and mark. Label the corners. This can be done on the face or back of the print.

3. Transfer the detail from the photographs to the map, section by section, quarter section by quarter section, or by any other subdivision for which survey information is available, by matching points on the photos with equivalent points on the map. This transfer can be done on a tracing table or with a Vertical Sketchmaster or Multiscope. Force the photo-detail to fit into the plotted points. Work only inside of plotted points. Do not extend compilation outside of the plot, since errors tend to accumulate rapidly where there is no control.

The Radial Line Plot

If General Land Office survey information is lacking, incomplete, or unreliable, the alternative procedure is to develop a radial line plot. The radial line plot is a photogrammetric triangulation procedure by which the photo-images are oriented and placed in proper relationship to one another and to ground control. A radial line plot can be constructed without ground control, but then the photo-images are only put in proper relationship to one another and may or may not be properly oriented as to a given meridian or have the required scale. For this reason it is imperative to have accurately surveyed ground control. This control can be obtained in several ways. These are: (1) using a road survey net, (2) using a self-surveyed triangulation net, (3) using a boundary survey adjusted by latitudes and departures, (4) using state rectangular grid coordinates of known points, or (5) using geodetic coordinates (latitude and longitude) of known points such as U. S. Geological Survey or U. S. Coast and Geodetic Survey bench marks or triangulation stations.

Surveyed ground control is most effective when it is properly distributed. Experiments have proved that well scattered control points are much more effective than concentrated points (*2*). A rather effective analogy is a wagon wheel. If one tries to keep the wheel from turning by grasping the axle he will have little success. If, on the other hand, he grasps the rim, he can resist rotation much more easily. Ground control in a radial line plot works much the same way. It is very effective around the margins of the plot, particularly across the ends of the flight strips. It is even better, however, if the control is well scattered over the entire area. Whenever any map compilation is attempted outside of the control net, errors tend to accumulate rapidly. The minimum number of control points for plots involving small areas, up to four flight strips in width and six photographs in depth, would be four points. These should be close to each corner of the area, but they should still be common to at least three photographs. More points would be desirable but no less. As the area becomes larger, additional control points should be used. For a graphical (transparent templet) radial line plot, it is essential to reduce bridging between control points to no more than three photographs. With mechanical triangulators this can be extended to four or five.

To facilitate laying down the plot, particularly if it is a graphical plot, two or three control points should be common to the first pair of templets laid down. This provides them with a two- or three-ray resection and should orient them correctly from the beginning. If this situation is not present, a good deal of difficulty will be encountered in getting the original flight strip correctly oriented and adjusted to scale.

Using a Net of Road Surveys

In some areas it is possible to obtain state or county road survey data that can be plotted to form a map of the roads netting the area. Road intersections or other identifiable points on these surveys can be used as control points for the radial line plot and the remaining portion of the plotted road net can be used as a skeleton over which the photo-detail can be plotted. Normally this would involve considerable time and would be an expensive operation. It is recommended only if available existing maps meet the requirements of the problem. If, however, the road survey notes have been reduced to state grid coordinates, the key control points can be plotted without difficulty. (See discussion on state rectangular grid coordinates.)

Using a Self-Surveyed Triangulation Net

Establishing a self-surveyed triangulation net is a highly technical and expensive operation. It should not be attempted by other than a qualified engineer. It is not recommended for forest mapping except in virgin areas where no previous work has been done. This condition will be rarely encountered in the United States. In Canada, Central and South America, and other undeveloped areas, however, the problem is a common occurrence and triangulation and astronomical observations are probably the only practicable way to obtain accurate ground control.

Using a Boundary Survey Adjusted by Latitudes and Departures

Where a boundary survey has been run by metes and bounds and closed or tied into known points

5-9B

CP-63C Derby Quad.
Connecticut Geodetic Survey
New Haven, Conn.

Station No: 77

Town: Woodbridge

County: New Haven

Date: June 11, 1934

Distances and Directions to Reference Marks

Object	Dist. Ft.	Direction			Plane Azimuth		
Mon. #76	1143.50	0	00	00	85	29	50.6
R.M. #1	127.0	43	11	00			
R.M. #2	111.8	221	26	20			
R.M. #3	120.63	300	20	40			

Plane Cordinates (Feet)
x 530,842.93
y 198,763.40

Elevation
Feet: 478.626
Meters: 145.8855

Oct., 1949

Station Mark is U.S.C. & G.S. & State Survey Bronze Disk Stamped: 77, set in the top of a reinforced concrete post, the top flush with the ground. The station is at the junction of Conn. #67 and Conn. #63 known as Payne's Corner. It is in a small triangular state highway island at the intersection of the 2 highways, 25.1 feet from the center-line of Conn. #63, 25.7 feet from the center-line of the north branch of Conn. #67, and 21.25 feet from the center-line of the south branch of Conn. #67.
R.M. #1: Northwest of station: The southeast corner of barn owned by Mr. Jacobs, north of the intersection of the 2 highways.
R.M. #2: Southeast of station: The northwest corner of a house owned by L.B. Fraser, on the east side of Conn. #63.
R.M. #3: Southwest of station: The northeast corner of the north ell of the house owned by B.R. Dudley, southwest of the intersection of the 2 highways.

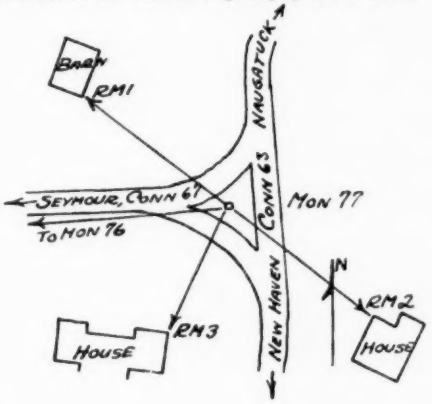

FIG. 1.—Example description of control point. Note plane coordinates.

(including areas in the G.L.O. section of the country), it can be used as control for a radial line plot. On small areas (up to 3,000 acres) the detail can be plotted in much the same manner as with the G.L.O. survey data previously described, with the exception that the area should be broken up into triangles and the plotting done inside the triangles. On larger areas the computed latitudes and departures can be used to position control points.

Procedure

1. Compute latitude and departures for the closed traverse and compute and apply corrections to bring the traverse error of closure to zero.

2. Compute the cumulative latitudes and departures, and tabulate.

3. Select survey stations for radial line plot control points, in order to set up an effective control net. (See introductory discussion on the "Radial Line Plot.")

4. Locate these stations in the field and identify them on the photograph. Prick points with needle and mark. The usual mark is a circle about 0.5 inch in diameter. The points should be labeled either on the face or back of the prints.

5. Plot the boundary survey on the base map sheet by means of the latitudes and departures.

6. On the base map sheet, circle the station chosen in step 3. The circles should be the same size as on the photos, if the map and photo scales are alike. This aids in transfer of the detail.

7. Using the above points as control, construct the radial line plot.

Using State Rectangular Coordinate Systems

All of the states, in conjunction with the U. S. Coast and Geodetic Survey, have established rectangular coordinate (grid) systems for use within their boundaries (*3*). These systems are graduated in feet or yards from a principal meridian and a baseline or standard parallel.

All of the lines are parallel or perpendicular to these principal axes. Scattered over such states are accurately located points (similar to bench marks) whose grid coordinates are known. If ties are made into two or more of these control points and a traverse adjusted by latitudes and departures to fit the actual distance between these points, it is very easy to find the grid coordinates of each station in a traverse. Thus the traverse can be plotted and be accurate in relation to all other surveys tied into the grid.

Information concerning known

points can be obtained from the U. S. Coast and Geodetic Survey, state highway departments, or the department in which the state places the responsibility for its survey. In some states photostats of point descriptions can be obtained for the price of the photostating. An example of such a description is shown in Figure 1. In other states the information is distributed in mimeograph form.

Procedure

1. Locate points in the field for which the state grid coordinates are known. Identify these points on the photographs. Prick point with needle, circle, and label.
2. Construct the desired portion of the state grid to the selected scale and label x and y grid lines.
3. Plot the coordinates of the known points and label.
4. Use these known points as control points and construct the radial line plot. If the area is extensive enough so that more than five photographs are needed to bridge between control points, add control points (if available) as needed to reduce the distance bridged.

Using Geodetic Coordinates (Latitude and Longitude)

In areas where known points or markers have not been tied into the state rectangular coordinate system and where other surveys are lacking or unsatisfactory, it is possible to use geodetic coordinates or latitude and longitude. To most foresters the terms "latitude and longitude" mean little except that they are used in navigation. Actually they are universal coordinates that apply to the whole world and are in angular units rather than ordinary units of distance. The actual lengths of the angular units change with latitude north and south of the equator because of the curvature of the earth. Thus it becomes necessary to convert the angular distances to units of length before they can be used. This process is complicated by the necessity for reducing earth curvature to a flat plane. Cartographers have established various types of plots or "projections" in attempts to reduce this distortion to a minimum. There are several such plots in common use. The "Lambert Conformal" and the "Transverse Mercator" are used as bases of state rectangular coordinate grid systems. The normal "Mercator" is used in navigation in the middle latitudes and the "Stereographic" in the high latitudes. The U. S. Geological Survey uses the "Polyconic" for its topographic quadrangles. The Polyconic projection is satisfactory for small areas (up to a 15 minute quadrangle), is easy to plot, and requires only a relatively simple universal table of conversion factors in order to plot it (*1*). For these reasons it is felt that the Polyconic projection has value in forest photogrammetry.

UNION SPRINGS QD. ALA. ALABAMA
TRANSIT TRAVERSE
UNION SPRINGS QUADRANGLE

7/21/42 -emf -1- 1927 N.A.D.
Bks. D1806; D1818

MACON COUNTY

TRANSIT TRAVERSE (by C.W.A. under supervision of U.S.F.S.) Station	Latitude o ′ ″	Longitude o ′ ″	Dist. Bet. Stations Feet
3196∤ Rd. crossing	32 14 48.99	85 43 21.64	. . . .
3198. Fort Davis, 75 ft. W. of seedhouse on W. side of Main Street, 80 ft. N. of main Seaboard Air Line R.R. track, in concrete post; standard tablet stamped "U S G S 36 1934"	32 14 48.99	85 42 38.14	3964
1382=4046. Roba, at NE corner of intersection of crossroads and 65.5 ft. N. of S.A.L. RR. Sta.; "U S G S 34"	32 14 38.16	85 35 34.24	9996
1386∤. Crossroads	32 14 30.19	85 37 30.17	. . . .
1391∤. Rd. crossing	32 14 22.38	85 39 18.44	9340

FIG. 2.—Example of U. S. Geological Survey Notes.

In most sections of the country, the U. S. Geological Survey or the U. S. Coast and Geodetic Survey have made surveys of one type or another. Normally the first type of survey used is a triangulation net that ties the major points of interest together and forms a base on which to build more information. Secondary surveys are then run, establishing bench marks and defining roads and other major planimetry. Both types of surveys result in points of known position, such as triangulation stations or bench marks. The locations of the points are stated in latitude and longitude. When available such points are ideal for setting up control for a radial line plot. Descriptions and geographic coordinates of such points can be obtained by writing to the Map Information Office, U. S. Geological Survey, or to the Director, U. S. Coast and Geodetic Survey, both in Washington, D. C. Figure 2 is a quotation from such information.

The following is an example of a typical problem involving geodetic coordinates solved by use of a modified polyconic projection and abridged tables.

Problem

Construct a 5 minute quadrangle at a scale of 1:20,000 with the coordinates of the SE corner being 35° 40′ N. lat. and 92° 45′ W. long. On this quadrangle plot the position of BM 1902 whose coordinates are 35° 41.6′ N. lat. and 92° 47.2′ W. long.

Procedure

It is good practice to make a sketch as shown in Figure 3 and then follow the operation working the computations and inserting the computed data on the sketch. When the sketch is complete, use it

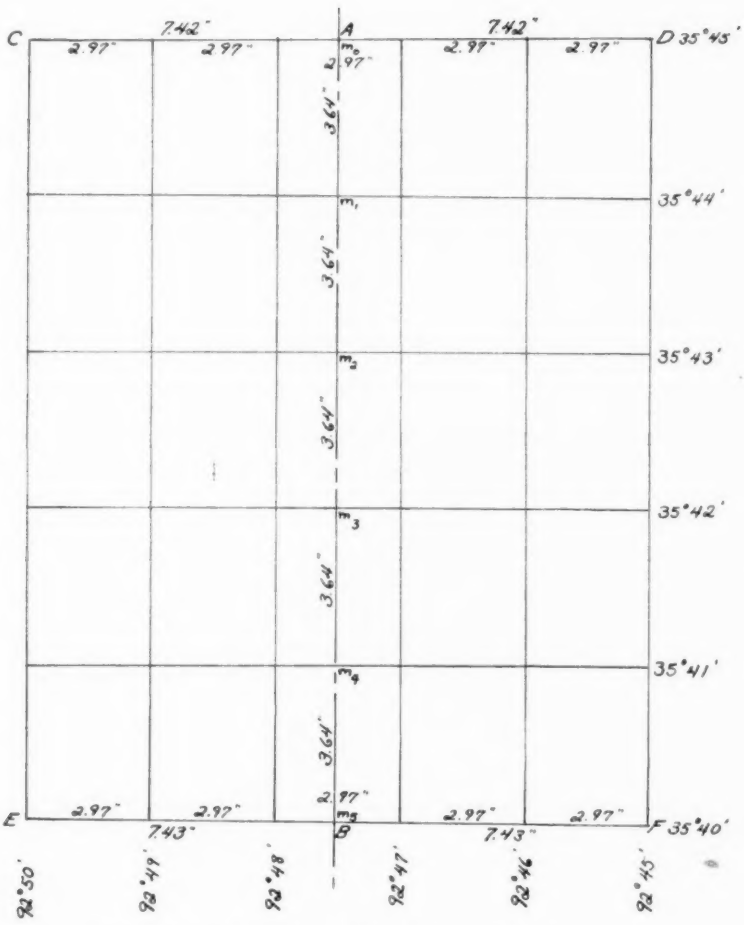

FIG. 3.—Sketch showing dimensions of the Polyconic projection.

as a guide in actually plotting the data (*5*).

1. On the base sheet construct line AB running due north and south. This is the central meridian.

2. At the top of the plot, at point m_0, construct a line perpendicular to AB. This should be done with great care, usually by intersecting arcs.

3. Compute distances m_0-m_1, m_1-m_2, m_3-m_4, and m_4-m_5 and convert to inches. This is done as follows:

a. Each of the distances m_0-m_1, m_1-m_2, etc., represents 1 minute or 60 seconds of latitude.

b. Enter table 1, and extract the "Mean value of 1" of latitude" for the nearest degree of latitude.

In this case the nearest degree of latitude is 36°. The mean value of 1" of latitude is 101.13 feet.

c. Multiply the above by the number of seconds of latitude. $101.13 \times 60 = 6067.8$ feet between parallels of latitude.

d. Convert to inches at the given scale.

Scale of plot in this case 1:20,000

$$\frac{6067.8 \times 12}{20{,}000} = 3.64".$$

4. Using a beam compass or engineer's scale, plot points m_1, m_2, m_3, m_4, and m_5 on line AB using the computations from above.

5. Construct lines perpendicular to AB through points m_1, m_2, m_3, m_4, and m_5.

6. Compute CA and AD along line m_0 convert to inches, and plot.

a. In this case CA and AD each represent 2½ minutes of longitude for a total width of 5 minutes.

CA = 2½ minutes or $2.5 \times 60 =$ 150 seconds, also AD = 150 seconds.

b. Enter table 1 and extract the length of 1" of longitude at the given latitude.

In this case the latitude is 35° 45'. The value of 1" of longitude at this latitude is 82.43'.

c. Compute the lengths of CA and AD.

Multiply the angular length in seconds (step *a*) by the length in feet for one second (step *b*).

In this case: 150 secs. × 82.43 feet = 12,364.5 feet.

Convert to inches:

CA = $12{,}364.5 \times 12 \div 20000 =$ 7.4187".

AD = $12{,}364.5 \times 12 \div 20000 =$ 7.4187".

d. Plot CA and AD along line m_0.

7. Compute EB and BF along line m_5, convert to inches, and plot.

Repeat procedure outlined in step 6.

In this case:

EB = $12{,}376.5 \times 12 \div 20000 =$ 7.4259".

BF = $12{,}376.5 \times 12 \div 20000 =$ 7.4259".

8. Connect points C and E and D and F.

Since the effect of earth curvature is so small on an area of this size there is no need for attempting to plot a curve into the parallels of latitude. The only noticeable effect of earth curvature is to pull the meridians together at the top and this narrowing has been computed and included in the plot.

9. Divide the lines CD and EF into fifths by means of dividers or by dividing the total length of the lines by five and plot.

In this case:

```
  7.42
 +7.42
5 ) 14.84
    2.968" Length of 1/5 of CD

  7.43
 +7.43
5 ) 14.86
    2.972" Length of 1/5 of EF
```

10. Connect corresponding points on CD with those on EF. Plot is then complete.

TABLE 1.—CONVERSION OF SECONDS OF LATITUDE AND LONGITUDE TO FEET (6)

	Minutes of latitude	Latitude of arc (values in feet for single seconds)												
		25°	26°	27°	28°	29°	30°	31°	32°	33°	34°	35°	36°	37°
For arcs of parallel	0	92.00	91.25	90.46	89.64	88.80	87.93	87.04	86.12	85.17	84.20	83.20	82.17	81.12
	5	91.94	.18	.39	.57	.73	.86	86.96	86.04	.09	.11	.11	.09	81.03
	10	.88	.11	.32	.51	.66	.79	.89	85.96	85.01	84.03	83.02	82.00	80.94
	15	.82	91.05	.26	.44	.59	.72	.81	.89	84.93	83.95	82.95	81.91	.85
	20	.78	90.98	.19	.36	.52	.64	.73	.81	.85	.86	.86	.82	.77
	25	.69	.92	.12	.29	.44	.57	.65	.73	.77	.78	.77	.74	.68
	30	.63	.85	90.05	.23	.37	.49	.58	.65	.68	.70	.69	.65	.59
	35	.57	.79	89.98	.15	.30	.41	.51	.57	.60	.61	.60	.56	.50
	40	.50	.72	.91	.09	.23	.34	.43	.49	.52	.53	.51	.48	.41
	45	.44	.65	.85	89.02	.16	.27	.35	.41	.44	.44	.43	.39	.32
	50	.37	.59	.78	88.94	.08	.19	.27	.33	.36	.37	.34	.30	.23
	55	.31	.52	.71	.87	88.01	.11	.19	.25	.28	.28	.26	.21	.14
	60	91.25	90.46	89.64	88.80	87.93	87.04	86.12	85.17	84.20	83.20	82.17	82.12	80.05
Meridional arcs	Mean value of 1″ of latitude—	100.95	100.97	100.98	101.00	101.01	101.03	101.04	101.05	101.08	101.09	101.11	101.13	101.14
		38°	39°	40°	41°	42°	43°	44°	45°	46°	47°	48°	49°	50°
For arcs of parallel	0	80.05	78.95	77.83	76.68	75.51	74.31	73.10	71.86	70.60	69.32	68.01	66.69	65.34
	5	79.96	.86	.73	.58	.41	.21	73.00	.75	.49	.21	67.90	.57	.23
	10	.87	.76	.64	.48	.31	.11	72.89	.65	.39	.11	.79	.46	.12
	15	.78	.67	.55	.39	.21	74.01	.79	.55	.28	69.00	.68	.35	65.01
	20	.68	.58	.45	.29	.11	73.91	.69	.44	.17	68.89	.57	.24	64.89
	25	.59	.48	.35	.19	75.01	.81	.59	.34	70.06	.78	.46	.13	.78
	30	.50	.39	.25	.10	74.91	.71	.48	.23	69.96	.67	.35	66.02	.66
	35	.41	.30	.15	76.00	.81	.61	.38	.13	.86	.56	.24	65.90	.55
	40	.32	.20	77.06	75.90	.71	.51	.28	71.02	.75	.45	.13	.79	.44
	45	.23	.10	76.97	.80	.61	.41	.17	70.91	.64	.34	67.02	.68	.32
	50	.13	78.01	.87	.70	.51	.31	72.07	.80	.53	.23	66.91	.56	.21
	55	79.04	77.92	.77	.60	.41	.21	71.97	.70	.42	.12	.80	.45	64.09
	60	78.95	77.83	76.68	75.51	74.31	73.10	71.86	70.60	69.32	68.01	66.69	65.34	63.98
Meridional arcs	Mean value of 1″ of latitude—	101.16	101.18	101.20	101.22	101.23	101.25	101.27	101.29	101.31	101.32	101.34	101.36	101.38

To locate a given bench mark proceed as follows: (In this case BM 1902 35° 41.6′ N. lat. 92° 47.2′ W. long.)

1. To plot latitude:

a. Enter table 1 and extract the "mean value of 1″ of latitude" at the given latitude. Since there is little change in this value, use the nearest degree of latitude.

In this case 35° is the nearest degree of latitude and the mean value of one second of latitude is 101.11 feet.

b. Multiply the above value for 1 second by the number of seconds difference in latitude the bench mark lies from the next lower parallel.

In this case the next lower parallel is 35° 41′.

The difference is:

35° 41.6′
−35° 41.0
0.6′ or .6 × 60 = 36 secs.

Multiply the above by the mean value of 1 second. 36 × 101.11 = 3639.96 feet.

c. Convert to inches and plot.

$$\frac{3639.96 \times 12}{20000} = 2.184''$$

The bench mark thus lies 2.184″ above the parallel 35° 41.0′ N.

2. To plot longitude:

a. Enter Table 1 and extract the length of 1″ of longitude at the given latitude. Since the latitude is usually not an even multiple as shown in the table, it usually will be necessary to interpolate. The interpolation can be made as though a straight line relationship existed.

In this case:

The length of 1 second of longitude is:

35° 40′ = 82.51 feet
35° 45′ = 82.43 feet
.08 feet difference

The correction per minute of latitude is:

$$\frac{.08}{5} = 0.016 \text{ feet/minute}$$

Multiply by the difference in latitude of the point and the nearest parallel to find the correction in length of 1 second of longitude:

35°41.6′=latitude of BM 1902
−35°40.0′=latitude of nearest parallel
1.6′ difference

0.016 × 1.6 = 0.0256 or 0.03 feet

Add correction (algebraically) to value of one second of longitude at the nearest parallel.

82.51′
−.03′
82.48′ = 1 second of longitude at 35° 41.6′ N Lat.

b. Multiply the above value by the number of seconds difference in longitude between the bench mark and the next lower meridian.

In this case the next lower meridian is 92° 47′.

The difference is

92° 47.2′
−92° 47.0′
0.2 or .2 × 60 = 12 secs.

Multiply the above by the value for one second:

12 × 82.48 = 989.76 feet

c. Convert to inches and plot:

$$\frac{989.76 \times 12}{20000} = 0.594''$$

The bench mark lies 0.594″ west of meridian 92° 47′ W.

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Past President Drake Receives Testimonial

Symbolizing their appreciation for his outstanding leadership as president of the Society of American Foresters for the 1952-1953 term, two hundred members of the organization personally signed a testimonial for retiring President George L. Drake and presented him with the greeting as a Christmas present.

Presentation to President Drake was made at his office in the Simpson Logging Company at Shelton, Wash., by Gordon Marckworth, dean, School of Forestry, University of Washington. Dean Marckworth was chosen by Chairman Ed Loners of the Puget Sound Section to speak for all Society members in his capacity as a member of the Council.

The signatures were gathered at the three-day annual meeting of the Western Forestry and Conservation Association in Seattle, Dec. 9, 10, 11. While signatures from the several West Coast Sections predominated, it was made clear in the presentation that these signatures were but a token of the Society membership at large.

The testimonial was in the form of a large card bearing an original color cartoon of President Drake in dual role of logger and forester.

The Effect of Soil Profile Inversion on Tree Growth and Soil Properties

Robert R. Lindahl and Herbert A. Lunt

Formerly graduate student, Yale School of Forestry, and soil scientist, Connecticut Agric. Exp. Sta., respectively, New Haven.

IN FOREST soil investigations, the question of nutrient intake by tree roots is of considerable importance. Normally, most of the absorbing roots are confined to the upper 6 to 12 inches of soil, and it is this part of the profile which contains the greatest concentration of available nutrients. Such being the case, to what extent can a tree utilize nutrients that may be available at greater depths? How would a tree react if the zone of available nutrients was located at the lower part of the profile instead of at the top?

To obtain information on these questions and, at the same time, to learn what effect soil profile inversion might have on some of the physical and chemical properties of the soil horizons, an experiment was set up in which trees were grown in soil artificially placed in large steel cylinders.

Literature

The literature on tree growth and root distribution as affected by soil characteristics is voluminous, but less has been written on the ability of plants, especially trees, to utilize nutrients at various depths below the surface. The concentrating of roots in the upper portion of the soil profile is usually attributed to better aeration as a result of greater soil porosity and better structure, to a higher soil moisture content and more favorable soil temperature and to a higher content of organic matter and available nutrients (*12, 19, 25, 28*).

Crist and Weaver (*5*) grew barley in soils to which fertilizer was applied at various depths—in each case to a 6-inch layer. The maximum depth was 30 inches. They found that absorption of nutrients below the surface foot affects the quantity and quality of the yield materially even when the surface foot is abundantly supplied with nutrients. In earlier studies, reviewed by Kramer (*12*), Weaver et al reported that various crop plants can absorb water and nitrates from depths of 2.5 to 5 feet. Lemmermann et al (*13*) grew a number of crops in soil to which dicalcium phosphate was added at various depths down to 75-100 cm. They concluded that plants can absorb nutrients from a considerable depth in amounts sufficient to affect the yield. Similar results have been reported by Wahlenberg (*32*) and Sokolav (*26*).

Steel cylinders have been used successfully by the Pennsylvania Station (*21*) for growing apple trees. It was found that moisture was a limiting factor unless the cylinders were irrigated.

The writers are not aware of any studies dealing with root development and tree growth on inverted soil profiles.

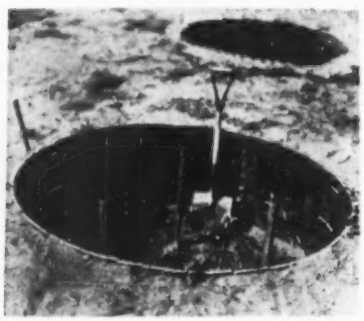

FIG. 1.—View of cylinder in place and partially filled. The vertical pipes, inserted to provide air to the buried A horizon proved to be ineffectual so far as could be determined by plant and soil-property measurements.

Experimental Procedure

The site of the experiment was a level, sandy river terrace just south of the nursery in Peoples State Forest, Barkhamsted, Connecticut. The elevation is about 450 feet above sea level, with hills on both sides of the narrow valley rising 400 to 600 feet higher. The work was initiated in 1941.

Sixteen steel boiler plate cylinders, 5 feet in diameter and 40 inches in depth, were placed in the ground with the rim about an inch above the ground surface (Fig. 1). The base of the cylinders rested on the coarse sand subsoil of Merrimac loamy sand.

In June, 1942 the cylinders were filled with Charlton fine sandy loam obtained from an open field in another part of the forest. The soil supported weed growth and in places had a light sod cover. The soil horizons were kept separate and hauled to the site by truck. The four treatments, in quadruplicate, were as follows:

I. Normal profile
   A horizon 0-8 inches
   B horizon 8-28 inches
   C horizon 28-38 inches
II. Inverted profile
   C horizon 0-8 inches
   B horizon 8-28 inches
   A horizon 28-38 inches
III. Inverted profile as in II but with three 1¼ inch iron pipes extending vertically from the surface to the buried A horizon for aeration
IV. All top soil

Figure 2 is a ground plan of the cylinder arrangement. The 16 cylinders were filled simultaneously and uniformly, the soil being well tamped into place.

The soils in this region are in the Brown Podzolic great soil group. The Charlton series is a well drained, upland soil derived from unstratified glacial till. It is usually considered productive for

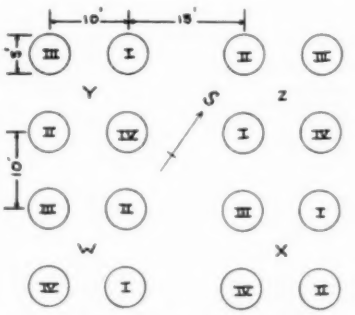

FIG. 2.—Plan of the cylinder layout. I = normal profile, II = inverted profile, III = inverted profile with aeration pipes, and IV = all topsoil. W, X, Y and Z are the four replicated blocks. Treatments were randomized within each block.

TABLE 1.—DATA ON THE ORIGINAL SOIL USED IN THE EXPERIMENT

Horizon	pH	Total N	Organic carbon	C:N ratio	Loss on ignition	Exch. H m.e.[1]	Exch. Ca m.e.[1]	Exch. Mg m.e.[1]
		Percent	*Percent*		*Percent*			
A	5.05	0.193	3.44	17.8	7.4	7.35	2.29	0.21
B	5.34	.089	1.96	22.0	4.8	4.37	0.73	.17
C	5.26	.044	0.98	22.3	2.7	2.69	0.37	.16

Horizon	Exch. K m.e.[1]	Base capacity m.e.[1]	Available P ppm	Moist. Equiv.	Sand	Silt	"Colloids"[2]	Clay
				Percent	*Percent*	*Percent*	*Percent*	*Percent*
A	0.17	11.28	11.2	22.9	52.3	33.1	24.0	14.6
B	0.10	6.95	8.6	20.2	55.6	29.6	23.2	14.8
C	0.10	4.29	8.0	15.7	58.9	24.5	24.2	16.6

[1]Milliequivalents per 100 g. air dry soil.

[2]Material in suspension after 15 minutes. Determined by the Bouyoucos method (*2*).

grass, hay, silage corn, potatoes and apples when limed and fertilized, and is one of the better forest soils. It possesses the following general characteristics:

A horizon. — Medium to dark gravish-brown or brown fine sandy loam, containing up to 5 or 10 percent of small fragments of mica schist; loose; weak to medium fine crumb structure; strongly acid.

B horizon. — Light yellowish-brown to yellowish brown, tending toward an olive color with increasing depth; fragments of schist and an occasional large boulder; firm in place, friable when removed; weak, very fine crumb structure; strongly acid.

C horizon. — Olive color; compact in place, friable when removed; medium platy; strongly acid.

Data on the original soil, sampled at the time the cylinders were filled and analyzed shortly after, are shown in Table 1.

Shortly before planting, gypsum blocks for estimating soil moisture by the electrical resistance method (*3*) were placed in the 12 outside cylinders. With the aid of a small posthole auger three such blocks were placed at a depth of 18 inches and three at 33 inches in each of the 12 cylinders.

In May, 1943, six graded hybrid poplar cuttings,[1] later reduced to three, and one rooted white pine (*Pinus strobus* L.) cutting[2] were planted in each cylinder. After two seasons the poplars were cut off at the ground level, stripped of leaves and weighed. They sprouted the following spring and in the fall were again cut and weighed. After that they were repeatedly cut back until dead. Four of the pines died and were replaced by potted trees.[3]

Total height and growth of the pines were measured annually. The cylinders were weeded several times, and gypsum block resistance readings obtained occasionally during dry periods. When this phase of the experiment was terminated in the fall of 1950, the pines had been growing in the cylinders eight seasons. Final measurements included total height, stem diameter at the ground level, and green weight of the entire tree above ground.

Most of the studies on soil properties and root distribution were confined to the southwest half of the cylinders. To determine root distribution, five 1-liter soil samples were taken from each horizon by means of a steel cylinder 10 cm. long and approximately 11 cm. in diameter. These sampling positions were: (1) in the top layer after removal of about the first inch; (2) at a depth of 19 inches for the middle section, and (3) at 33 inches for the bottom horizon. The samples were screened and the roots washed, oven-dried, and weighed.

In addition to the root samples three 250 ml. soil-in-place samples were taken from each horizon for determining physical properties. These samples were collected in brass cylinders measuring $2^7/_8$ inches by $2^5/_{16}$ inches, by means of a soil core sampler (*27*).[4] Also two loose samples were collected from each horizon for chemical analysis.

Later, the remaining (northeast) half of the top horizon was removed, screened and the roots weighed.

Methods of Analyses

Waterholding capacity: The 250-ml. cylinder samples were soaked in water overnight, then drained by placing on a thick mat of newspapers for 24 hours, weighed, oven dried and reweighed. Bulk density: Water-free weight of the soil, divided by volume of the cylinder, after correcting for weight and volume of stones failing to pass a 6-mesh-to-the-inch screen. Specific gravity was determined with 25-ml. picnometers. Pore volume in per cent $= 100 - \frac{(\text{bulk den.} \times 100)}{\text{sp. gr.}}$.

Mechanical analysis was run by the Bouyoucos method (*2*).

Chemical analyses on the 96 samples were made as follows: pH by means of a glass electrode pH meter; nitrate nitrogen by the method of Harper (*7*); exchangeable calcium by the Wolf method (*33*); available phosphorus by the Truog method (*30*); organic carbon by the Schollenberger method (*24*), and total nitrogen by the usual Kjeldahl method. Exchangeable potassium was first determined simultaneously with calcium by the Wolf method but later it was repeated, using the flame photometer method of Toth and Prince (*29*).

Results

Tree Growth Data

The data on the poplars are shown graphically in Figure 3.

[1]All cuttings were from a single clone designated as OP-8 whose parentage is *Populus nigra* L. (female) × *P. laurifolia* Ledeb. (male). They were obtained through the courtesy of Dr. E. J. Schreiner of the Northeastern Forest Experiment Station.

[2]All pine cuttings came from a single tree in the Eli Whitney Forest near New Haven.

[3]Three of the four replacements were from the original clone.

[4]The sampler was driven into the soil with a hammer, using a block of wood as a buffer. Neither the tripod nor the wheel-mounted support, described by Swanson, were applicable in this work.

Growth of trees on the inverted profiles (treatments II and III) was approximately twice that on the normal profiles (treatment I); and growth in the all-topsoil cylinders (treatment IV) was nearly four times that in treatment I. This was true both years. There was no significant difference between II (inverted) and III (inverted with aeration pipes).

That the best growth occurred on all-topsoil indicates that hybrid poplars can take advantage of a greater depth of topsoil when it is provided. But the better growth on the inverted profiles as compared with that on normal profiles is more difficult to explain. It may be theorized that the difference in growth was due to two principal factors, namely: (1) where the top soil (A horizon) is buried it remains moist during the growing season and thus provides nutrients that might otherwise not be available where the normal topsoil at the surface becomes dry,[5] and (2) where the C horizon is placed at the surface the exposure to the elements releases nutrients that would ordinarily not be available. These theories will be discussed later after consideration of the soil data.

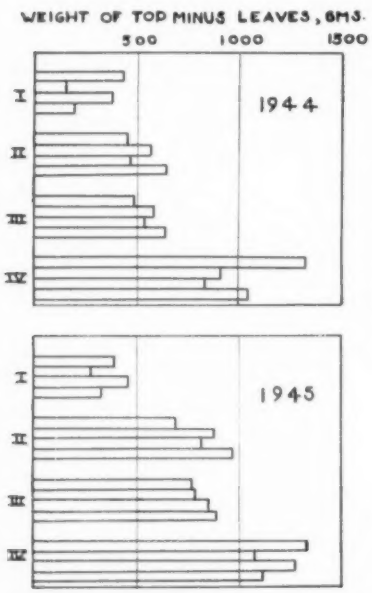

FIG. 3.—Green weight of the tops of poplars, exclusive of leaves. Each value shown is the average of three trees in a cylinder. The four bars represent the four replicates, W, X, Y, and Z in order from the top to bottom.

The 1945 data pertains to sprout growth made during 1945, following cut-back of the original growth in the fall of 1944.

Growth data on the white pines are presented in Table 2 and Figure 4. It is apparent that growth differences were smaller and much less consistent than was the case with poplars. The rather wide variability in tree size within treatments, due in part to the fact that there was only one tree per cylinder and there were losses and replacements, precluded statistical significance of the growth data. However, the results show that the trees on the inverted soils were larger for the most part than those on the normal soils, but the trees on the all-topsoil were a little smaller on the average than those on the inverted profiles.

The direct cause of death of the four trees (Table 2) which had to be replaced is not known. It is noteworthy, however, that all were on profiles where there was topsoil at the surface. To what extent weed competition was responsible could not be determined but it probably was a factor.

Table 3 shows the weight of pine roots in five liters of soil in each of the three segments of the profile. Here, again, the variations within the same treatment are so large that the treatment differences are not statistically significant. Nevertheless several items of importance can be gleaned from the data:

1. There were more roots in the top layer of the inverted profiles (i.e. in the surfaced C) than in the topsoil of the normal profiles.

2. There were more roots in the buried A horizon of treatments II, III and IV than in the normal C of treatment I.

3. In practically every case in treatments I, II and III the top layer had more roots than the bottom layer.

4. The total weight of roots in the entire profile was higher in both inverted and all-topsoil profiles than in the normal soil.

The data in Table 4 on surface soil roots in the northeast half of the cylinders confirm the top layer root data in Table 3.

[5]Wadleigh and Richards (*31*) have stated the negative aspect of this moisture-nutrient relationship in the following words: "If moisture is available in unfertile lower horizons of a soil and if most of the fertility is in the surface horizon that has become very dry, the plant may suffer from inadequate mineral nutrients."

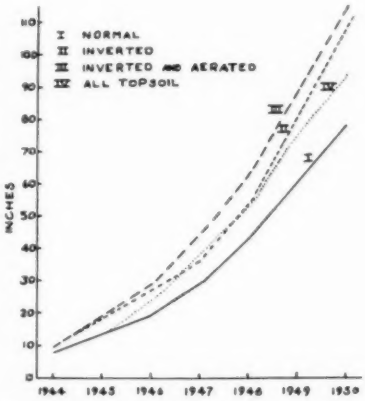

FIG. 4.—Accumulative total heights of white pine.

Physical Soil Properties

The data are summarized in Table 5. As would be expected,

TABLE 2.—GROWTH DATA FOR WHITE PINE

	Treatments											
	I Normal			II Inverted			III Inverted + aerated			IV All top-soil		
	Weight of top	Diameter[1]	Height	Weight of top	Diameter	Height	Weight of top	Diameter	Height	Weight of top	Diameter	Height
Block	*Pounds*	*Inches*	*Feet*	*Pounds*	*Inches*	*Feet*	*Pounds*	*Inches*	*Feet*	*Pounds*	*Inches*	*Feet*
W	16.75	2.4	8.8	19.50	2.2	10.3	12.13	1.8	7.9	19.87	2.3	9.4
X	8.87	1.8	7.1	16.50	2.3	8.2	37.37	3.1	11.8	12.63[4]	2.0	6.5
Y	5.75[2]	1.3	5.6	18.37	2.4	9.4	13.37	2.2	7.7	9.75[5]	1.9	5.7
Z	4.13[3]	1.0	4.8	18.00	2.3	8.6	28.25	2.7	10.5	21.13	2.3	9.6
Av.	8.88	1.6	6.6	18.09	2.3	9.1	22.78	2.4	9.5	15.84	2.1	7.8

[1]Diameter of stem measured 6 inches above the ground.
[2]Original tree replaced May 1944; a second replacement made October 1945.
[3]Original tree replaced April 1945.
[4]Original tree replaced June 1944 (different clone).
[5]This tree was observed to be somewhat poorer than the others in April 1945, but was not replaced.

TABLE 3.—WEIGHT OF PINE ROOTS IN THE THREE LAYERS OF THE PROFILE[1]

Blocks	Total dry weight in grams of roots in 5 liters of soil — Treatments — I Normal	II Inverted	III Inverted and aerated	IV All top soil
	Top layer 0-8 inches			
W	1.63	2.10	0.74	2.74
X	0.16	3.34	1.85	0.82
Y	0.32	4.24	1.53	0.04
Z	0.83	1.39	4.20	1.03
Total	2.94	11.07	8.32	4.63
Average	0.74	2.77	2.08	1.16
	Middle layer 8-28 inches			
W	1.27	0.40	0.15	0.59
X	0.16	0.37	1.34	5.06
Y	0.17	0.81	0.32	0.92
Z	0.78	1.46	2.39	5.89
Total	2.38	3.04	4.20	12.46
Average	0.60	0.76	1.05	3.11
	Bottom layer 28-38 inches			
W	0.47	1.78	0.73	2.04
X	0.24	0.38	2.86	0.51
Y	0.13	0.65	1.28	1.06
Z	0.14	1.18	1.41	1.20
Total	0.98	3.99	6.28	4.81
Average	0.24	1.00	1.57	1.20
Grand total	6.30	18.10	18.80	21.90

[1]Obtained by one-liter sampling cylinders on the southwest half only.

TABLE 4.—TOTAL PINE ROOTS IN SURFACE LAYER OF THE PROFILE[1]

Block	Dry weight in grams — Treatments — I Normal	II Inverted	III Inverted and aerated	IV All top soil
W	125	290	74	79
X	201	362	324	134
Y	24	123	141	147
Z	38	196	201	63
Total	388	971	740	423
Average	97	243	185	106

[1]Obtained by sieving all the surface soil in the northeast half of the cylinders.

pore volume and water-holding capacity are higher in the A horizon than in the C regardless of position. The data show, however, that burying the A horizon resulted in a 7.4 percent decrease in its total pore volume and, conversely, putting the C at the surface increased its pore volume 9.8 percent. These highly significant differences (determined by analysis of variance) are attributed to the compaction, or lack of it, due to position in the profile. Differences in pore volume and water-holding capacity between treatments I and II or I and III were significant, but not between II and III, or between I and IV.

Bulk density was affected similarly to pore volume but in inverse manner, i.e. the A being lower in density than the C.

Chemical Soil Properties

The data in Table 6 show that, in the normal profile, the pH was lowest in the A horizon and highest in the B. But where the A horizon was buried its pH was slightly increased, and the C horizon showed a decrease in pH when placed at the surface.

The nitrate nitrogen content decreased slightly with increasing depth in the normal profiles, and increased with increasing depth in the inverted profiles, — conditions

TABLE 5.—SUMMARY OF PHYSICAL DATA ON THE SOILS

Each value below is the average of 4 replicates — Treatments — I Normal	II Inverted	III Inverted + aerated	IV All topsoil	Blocks	Significance of differences: Treatments	I vs. II	I vs. IV	II vs. III	I+IV vs. II+III	I+II +III vs. IV	II vs. IV	I vs. II+III
							Total pore volume, percent					
Top[1] 63.4	52.7	52.1	61.9	0	xx	—	0	0	xx	—	—	—
Middle 58.6	57.0	55.1	58.0	0	x	—	—	0	—	0	—	x
Bottom 47.7	58.3	57.7	58.5	0	xx	xx	0	0	—	—	—	—
							Water-holding capacity, percent of water-free soil					
Top 33.7	26.7	27.1	33.3	0	xx	—	0	0	xx	—	—	—
Middle 32.8	31.5	32.4	35.5	0	xx	—	—	0	—	xx	—	0
Bottom 27.1	34.5	35.2	34.6	0	xx	xx	—	0	—	—	0	—
							Bulk density					
Top 0.91	1.23	1.25	0.95	0	xx	xx	0	0	xx	—	—	—
Middle 1.06	1.10	1.15	1.05	0	x	—	—	0	—	x	—	x
Bottom 1.37	1.05	1.05	1.04	0	xx	xx	—	0	—	—	0	—

xx — Highly significant (1 percent point).

x — Significant (5 percent point).

0 — Not significant.

— — Not determined for significance (usually lack of significance was obvious).

[1]The top layer was sampled at the 1 to 3 inch level.

Middle layer—18 to 20 inch level.

Bottom layer—32 to 34 inch level.

TABLE 6.—SUMMARY OF CHEMICAL DATA ON THE SOILS

Each value below is the average of 4 replicates	Treatments					Significance of differences						
	I Normal	II Inverted	III Inverted + aerated	IV All topsoil	Blocks	Treatments	I vs. II	I vs. IV	II vs. III	I+IV vs. II+III	I+II +III vs. IV	II vs. IV	I vs. II+III
pH													
Top	4.8	5.3	5.4	5.3	x	xx	—	xx	0	xx	—	—	—
Middle	5.8	5.5	5.6	5.0	x	xx	—	—	0	—	xx	—	xx
Bottom	5.6	5.2	5.2	5.2	0	xx	xx	—	0	—	—	—	—
Nitrate nitrogen ppm													
Top	1.2	0.3	0.2	2.1	0	xx	—	0	0	xx	—	—	—
Middle	0.9	0.5	0.4	1.9	0	xx	—	—	0	—	xx	—	0
Bottom	0.5	1.4	1.5	2.2	0	0	0	—	0	—	—	—	—
Available phosphorus, ppm													
Top	15	18	16	16	0	0	—	0	0	0	—	—	—
Middle	12	12	11	17	xx	x	—	—	0	—	x	—	0
Bottom	20	19	16	17	0	0	0	0	0	—	—	—	—
Exchangeable calcium m.e.													
Top	0.85	0.50	0.50	1.60	—	—	—	—	—	—	—	—	—
Middle	1.52	0.85	0.88	1.30	—	—	—	—	—	—	—	—	—
Bottom	0.60	2.10	2.02	2.15	—	—	—	—	—	—	—	—	—
Exchangeable potassium, m.e.													
Top	.077	.120	.125	.046	0	x	—	0	0	xx	—	—	—
Middle	.041	.041	.038	.041	0	0	—	—	0	—	0	—	0
Bottom	.049	.069	.046	.049	0	0	0	—	0	—	—	0	—

xx — Highly significant (one percent point)

x — Significant (5 percent point).

0 — Not significant.

— — Not determined for significance (usually lack of significance was obvious).

presumably related in some degree to the organic matter content of the three horizons.

In the normal profiles, available phosphorus was lowest in the B and highest in the C horizon, although the differences were small. Changes in phosphorus content upon profile inversion were slight. Quick tests of the surface soil sampled in the summer of 1949 had shown a somewhat higher concentration in the inverted profiles, II and III, than in either I or IV. Work in Indiana (*22*) has shown that the exposure of subsoil to the air increased the availability of P in that horizon.

Exchangeable calcium was lowest in the C horizon regardless of position, and the buried A had considerably more calcium than did the A in the normal profiles. The chief point of interest in the case of exchangeable potassium is the rather marked increase in the amount in the C horizon when brought to the surface. This result differs from that reported in Indiana (*22*) where it was found that the availability of potassium was about the same in the subsoil as it was in the surface.

Total nitrogen, organic carbon, and carbon-nitrogen ratios were determined on enough samples to show that no differences existed between treatments and the data have been omitted.

Discussion

The superior growth of poplars in the cylinders containing only topsoil treatment IV, was undoubtedly due in part to the greater nutrient capital available to the trees (*5*), and in part to the higher moisture content as measured by the gypsum blocks (Table 7).

The better growth of poplars on the inverted profiles II and III, as compared with that on the normal profiles I is believed to be due in part to more moisture in the bottom layer of the inverted profiles (Table 7). A second factor, previously mentioned, is the effect of a higher mositure content on nutrient availability. As the buried A was always moist, more nutrients would be available to the roots than where the A was in its usual surface position and frequently became quite dry. A third contributing factor was weed competition. In every case and throughout the experiment the inverted profiles were much freer of weeds and grass than were the profiles with the A horizon at the surface. This was due presumably to lack of weed seeds and to low level of nitrates. Although the cylinders were weeded from time to time, especially during the first two years, it was not possible to maintain them weed-free. A fourth possible contributing factor to the better growth on the inverted profiles is the higher content of exchangeable potassium and, presumably of available phosphorus, in the C horizon when at the surface.

In contrast to the poplars, the response of the pines was smaller and less clearly defined. That they did not benefit greatly by the abundant nutrient capital available in the all-topsoil cylinders is indicative of the relatively low requirements of *Pinus*. Previous work (*16*) showed that response to fertilization was much less pronounced

TABLE 7.—MOISTURE CONTENT OF THE SOIL, OBTAINED BY ELECTRICAL RESISTANCE READINGS OF BURIED GYPSUM BLOCKS[1]

	Normal I	Inverted II	Inverted and aerated III	All topsoil IV
18″ depth	21.1	20.0	20.4	24.9
33″ depth	17.6	26.6[2]	27.4	28.4

[1]Comparison by treatments and by depth, in percent of water-free soil. Averages of 18 measurements made during the summers of 1943 and 1944.

[2]An average of 17 measurements.

for *Pinus resinosa* and certain other conifers than for hybrid poplars. Lutz and Chandler (*18*) state, "As a rule, hardwoods absorb greater amounts of most mineral nutrients than do conifers. . . . The pines appear to make smaller demands on the mineral nutrient capital of soil than do any other trees." Of the hardwoods, hybrid poplars are probably the most demanding species, hence show the greatest response. The writers are inclined to believe, however, that, other conditions being equal, a stand of white pine growing on 38 inches of topsoil would eventually outstrip a similar stand with only 8 inches of topsoil at its disposal.

The somewhat better growth of pines in the inverted profiles in comparison with that on the normal profiles was presumably caused by the same factors responsible for the growth differences in the poplars. It is felt that the competition of the poplars during the first few years may have held back the pines somewhat.

In explanation of the large variability, hence lack of significance, in the root data, one must consider the wide variation in root systems of rooted cuttings. It seems to be characteristic of such plants for the roots to "take off" at nearly right angles in one or two directions (Figure 5). Inasmuch as the soil was removed from only one-half of the cylinder, (except for the top layer), the character of root systems could account in large measure for the variability found. Also, it must be kept in mind that confinement of the roots resulted in certain abnormalities, such as concentration along the cylinder wall, and in many cases abrupt deflection downward or laterally along the wall or, in some instances, back toward the center of the cylinder. In a few cases roots turned upward at the cylinder wall, grew over the rim and took root in the soil outside the cylinder.

The A horizon in the normal profile (treatment I) differed markedly from the soil in the corresponding position in the all-topsoil (treatment IV) with respect to pH, nitrate nitrogen, and exchangeable calcium, all of which were higher in the all-topsoil. A possible explanation is that upward capillary movement of water was instrumental in bringing soluble nitrogen and calcium to the surface, although such movement is contrary to what usually occurs in humid climates. Possibly it was a temporary condition occurring during the summer and disappearing again during the winter and spring. On the other hand, the data showed that both pH and exchangeable calcium of the A horizon were higher when that horizon was buried, indicating downward movement of calcium.

The exchangeable potassium content of the C horizon increased considerably where the C was placed at the surface. This could be brought about to some degree by alteration of soil minerals under the influence of water and Co_2. Another contributing factor would be the smaller amount of removal of potassium by weeds and grass inasmuch as the inverted profiles were nearly bare of surface vegetation during the entire period, as contrasted to the weedy normal and all-topsoil profiles. This factor would be effective chiefly where the weeds and grass were removed from the surface A horizon, thus preventing the return of K_2 to the soil as result of leaching and decomposition of the vegetation.

Possibly the higher content of K was one of the reasons why none of the pines died on the inverted profiles. Recent work (*8, 14, 17*) on the effects of slash mulches and fertilizer application on the growth of various conifers seems to indicate that under certain conditions, at least, they respond well to potassium.

The data in Tables 3 and 4 show more roots in the C horizon when it was at the surface than in the A horizon at the surface. Hunter and Kelley (*10*), in a study with alfalfa and guayule growing in a sectioned column of uniform "soil,"[6] found the greatest concentration of roots in the upper part of the soil column as in nature. They found, also, that these roots in the top section extracted moisture held at

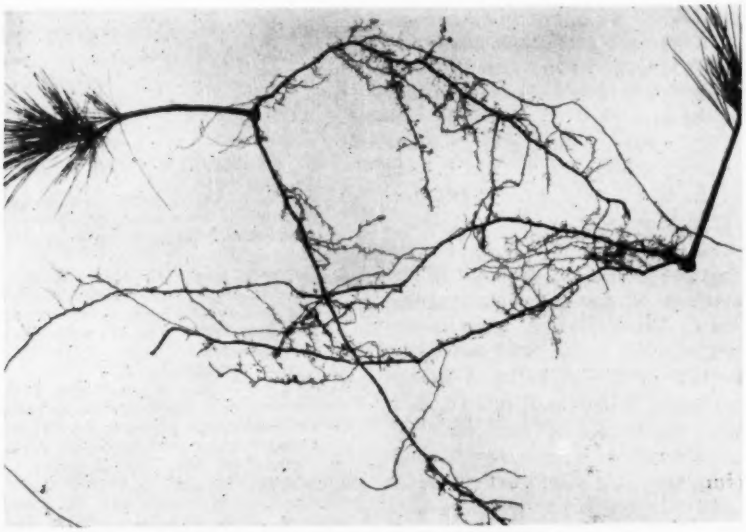

FIG. 5.—Root systems of two typical rooted white pine cuttings.

[6]Equal parts of Chaular loam, sand and fine gravel.

fairly high tensions even though moisture was available at low tensions in the "subsoil." These facts would point to aeration as an important and well known factor in root distribution (*4, 12, 23*). Usually moist, fertile soil favors a low root volume, i.e. intensive root development in a relatively small volume of soil (*4, 6, 23*), in contrast to low fertility or low moisture supply (as in coarse sandy soils) which favor a high root volume. Inasmuch as the moisture content of the surface horizons was not determined, it is not possible to say what role moisture played in these differences in root concentration of the top layers.

The only other cue to account for the greater root concentration in the surfaced C material is its higher content of exchangeable potash and available phosphorus. Although potassium is effective in promoting root growth of fleshy rooted crops like mangolds and beets (*23*), it is not usually considered a promoter of root growth in the case of other crops and trees. In fact potassium's exact role, aside from its effect in plant buffer systems, is still obscure (*9*). On the basis of Russell's (*23*) discussion, it is believed that an increase in the supply of available K, as well as phosphorus, can lead to increased root development, especially where available N is in only moderate supply.

The findings with respect to intake of nutrients from the buried A horizon appear to be in agreement with those of Hunter and Kelley (*10*) who found that guayule roots are able to absorb phosphorus supplied to the lower part of the soil column (below 48 inches) and transport it to the leaves and stems.

This experiment has shown that trees are able to utilize the nutrients present at lower depth (28-38 inches), and that in general, growth was increased where the profile was inverted.

These findings should have a practical application in tree and shrub planting. It appears that good results can be expected if the topsoil is placed in the bottom of the hole and the subsoil at the surface. This procedure has one advantage over using topsoil entirely for the back fill, in that weed competition is apt to be less of a problem where the C horizon material is at the surface. Where weeds can be controlled, it is expected that, generally speaking, most rapid growth will be obtained where the entire root system has access to topsoil.

Summary and Conclusions

In order to obtain more information on nutrient intake and root development of trees, hybrid poplar and white pine rooted cuttings were grown in steel cylinders containing Charlton fine sandy loam soil, altered as follows:

I Normal A/B/C profile
II Inverted C/B/A profile
III Inverted C/B/A profile with provision for aeration of the buried A horizon
IV All-topsoil

The growth of the poplars was twice as great on the inverted profiles and four times as great on the all-topsoil profiles as on the normal profiles. White pine, on the other hand, showed smaller and less clearly defined increases on the inverted profiles and even less increase on the all-topsoil treatment.

Root concentration of white pine appeared to be somewhat higher in inverted profiles in both top and bottom horizons than in the normal profile.

It was observed that grass and weed density and growth were much lower when the subsoil was at the surface.

Soil moisture during dry periods in the growing season was highest in the all-topsoil cylinders and lowest in those with normal profiles.

Soil studies indicated certain changes in the soil as result of the artificial change in profile arrangement. Where the A horizon was buried, (in comparison with the normal profile with the A at the surface), it increased in bulk density, water-holding capacity, pH, nitrate nitrogen, exchangeable calcium and, to a slight extent, available phosphorus. At the same time total pore space and exchangeable potassium content decreased. When the C horizon was brought to the surface it showed an increase in total pore volume and exchangeable potassium and a decrease in bulk density, pH, nitrate nitrogen and, to a slight degree, available phosphorus. There was an indication that available phosporus was higher in the surface C than in the normal A.

The upper portion of the all-topsoil cylinders contained somewhat higher values for pH, nitrate nitrogen and exchangeable calcium than did the A of normal profiles.

The provision for aerating the buried A horizon was ineffective so far as could be detected by growth response and soil analyses.

Indications are that the superior growth of the poplars on all-topsoil was due to greater total nutrient capital and higher moisture content. White pine is less exacting and failed to benefit under the same conditions.

The better growth on inverted profiles as compared with normal profiles is ascribed to a larger supply of available nutrients because of more moisture in the buried A horizon, and less weed competition. A somewhat higher concentration of exchangeable potassium and available phosphorus in the surfaced C horizon may be additional contributing factors.

It is concluded that tree roots can reach and utilize nutrients down to considerable depth below the surface. It is not necessary nor is it necessarily desirable to have the most fertile portion of the soil profile at the surface.

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Edward R. Linn (1877-1953)

Edward R. Linn passed away at Stillwater, Okla., on the morning of November 10, 1953. Born in Greenville, Ohio on May 3, 1877, he received his B.S. degree from Ohio State in 1910 and his Master's in Forestry at Yale University in 1913. He was a member of the Society of American Foresters and of the Forest Products Research Society of America.

In his earlier years, he worked for the Brown Paper Company in New Hampshire and Canada; after several years with them, he returned to Ohio to assist with the printing company operated by his family. After serving as forester for the Hardwood Manufacturing Association from 1929 to 1933, and as forest manager of the Southern Hardwood Producers Association from 1933 to 1941, he was consultant forester for the Southern Pine Association. On October 1, 1947 he joined the faculty of the Forestry Department of Oklahoma A & M College, where he taught logging, forest products, wood technology, and wood treatment.

He was author of the American Forest Reports of Florida and Kentucky, as well as a bulletin on Forest Industry Survey of Oklahoma, and many other papers and publications.

He will be missed by his many friends in and out of forestry circles.

HARRY P. RIGDON

A Malady of Red Pine on Poorly Drained Sites

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RED PINE (*Pinus resinosa* Ait.) has been extensively used in reforestation in northeastern United States. Its ease of establishment, rapid early growth and supposed freedom from most serious insects and diseases have encouraged its planting on a diversity of sites. New York State nurseries shipped some 225 million seedlings of this species in the period 1900-1945 and according to present plans it is to comprise 25% of total nursery production in the near future (*21*).

Although dying of small areas of red pine plantations from no well defined causes had been noted occasionally (*1-7*), the number of such reports increased materially after 1946. In view of the importance of the species a general survey was made in New York to determine the nature of the malady and possible means of control or prevention.

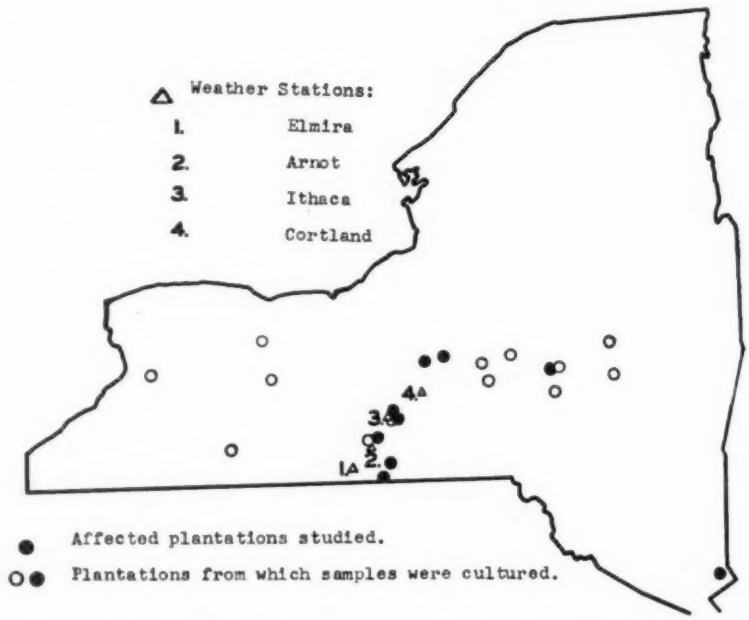

FIG. 1.—Location of affected plantations studied.

Observations

From 1949 to 1951 a number of unhealthy or dying plantations were studied and compared with adjacent unaffected stands. Locations of the principal affected areas studied are shown in Figure 1.

Occurrence and Symptoms

As Figure 1 suggests, occurrence of the malady is not limited geographically, and there is no obvious relationship to the limited range of climatic zones within the area studied. The affected plantations observed range in age from 5 to 40 years, although the majority were planted in the mid-thirties. They occur on a variety of slopes, from level to 25 percent, and are not confined to particular topographic positions. Many are associated with drainage ways and seepage areas, however, suggesting a relationship with soil drainage.

The malady expresses itself in various ways which may occur in proximity to one another and intergrading (Fig. 2). The most divergent manifestations are (1) a rapid dying of most of the trees following good intial growth and (2) prolonged stunting, accompanied by gradual death of individual trees. These two conditions are termed "A" and "C," respectively, for convenience in subsequent discussion, with an intermediate condition, "B," also recognized. The latter is characterized by poor to fair early growth followed by dying of individual and small groups of trees. This progresses more slowly than in "A" but with the same ultimate result. The designations are arbitrary and may in part reflect the age at which onset of the malady occurs.

Areas of stunting and slow growth, conditions "B" and "C," are more numerous and usually larger than areas of condition "A," which are usually five acres or less in extent.

Condition "A," which is the most striking, occurs in 15 to 40 year old plantations which to outward appearances have grown normally for some years (Fig. 3, 7, 8). Thereafter growth of the terminal shoot is reduced progressively for a period of 3 to 6 years, or until the tree dies. The usual pattern is ⅔ to ½ normal height growth during the first year of decline, ⅓ or less the second, and subsequently a few inches diminishing to sometimes less than an inch. The lateral branches are similarly affected, and accordingly the length of needle-bearing twig diminishes. This leads to a characteristic "tufted" appearance as the 3 to 5 annual suites of needles are crowded near the ends of the branches (Fig. 3). Reduced twig growth is often unrecognized from

[1]It is a pleasure to acknowledge the assistance of Fred Winch, state extension forester, who brought to our attention the widespread occurrence of the malady. We are indebted to H. C. S. Thom, visiting professor of Statistics at Cornell, for the method of analyzing rainfall records employed. Personnel of the N. Y. State Conservation Department and other foresters cooperated in the location of affected areas.

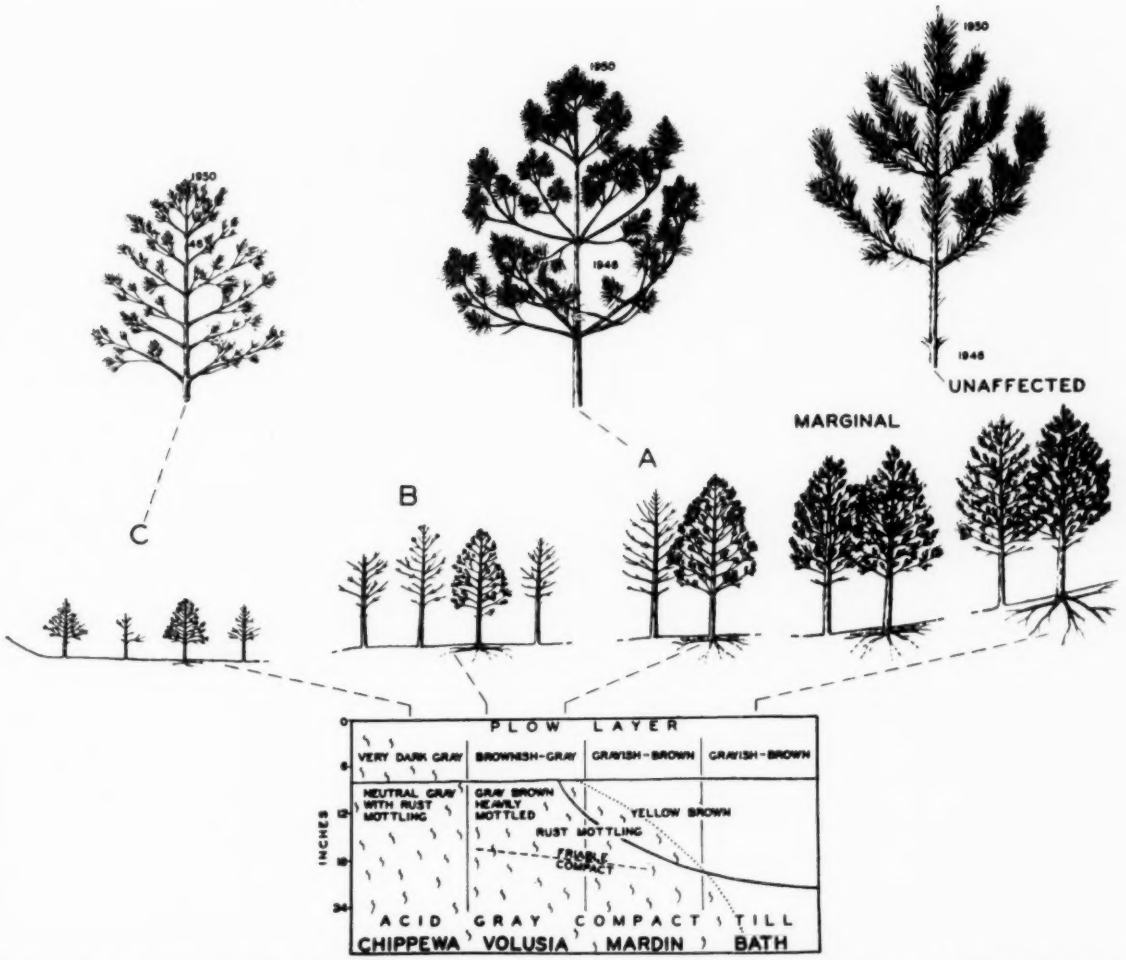

FIG. 2.—Top and root manifestations of the various injury conditions described, and their occurrence as related to soil type and morphology within the Bath catena. Soils progress from very poorly drained on the left to well drained on the right.

the ground in the incipient stages because few laterals arise to mark the closely-spaced nodes. Needle length is markedly reduced in the later stages and the last formed needles are frequently discolored. The tufted appearance is followed by death of the tree, usually within a year or two.

Radial growth of the stem may diminish before height growth is affected but, if not, its decline usually parallels that of the terminal shoot. In the one to three years prior to death the annual rings are from a few hundredths to less than one-hundredth of an inch in width. Commonly the last formed ring consists of spring wood cells only, indicating the season at which the cambium ceased to function.

In overstocked stands, reduction in radial growth occurs for some years before symptoms appear (Fig. 10, Varna). There appears to be no relation of crown class to the onset of the symptoms, however, and trees adjacent to openings are affected in the same manner as those in the interior of the stands.

In the intermediate condition "B" the symptoms closely resemble those of "A" except as the slower early growth renders the subsequent reduction less conspicuous. Severely stunted trees, condition "C," have seldom grown more than 4 to 9 inches in height each year, but further dwarfing, accompanied by shortened and yellowed needles, often precedes death of the individual trees. Due to establishment losses and stunted appearance, plantations characteristic of condition "C" are usually recognized as obvious failures by their tenth year (Fig. 9).

All of the soils on which affected plantations occur are classed as imperfectly to very poorly drained. The lateral root systems of severely stunted trees (condition "C"), are but sparsely developed and branch chiefly in the upper 3 inches of soil. Fine roots arising adventitiously from main roots near the trunk often form a mat at or near the surface of the ground. Some appressing roots may ascend the stem for an inch or two above the ground line, protected by bark scales and low branches.

location of affected areas.

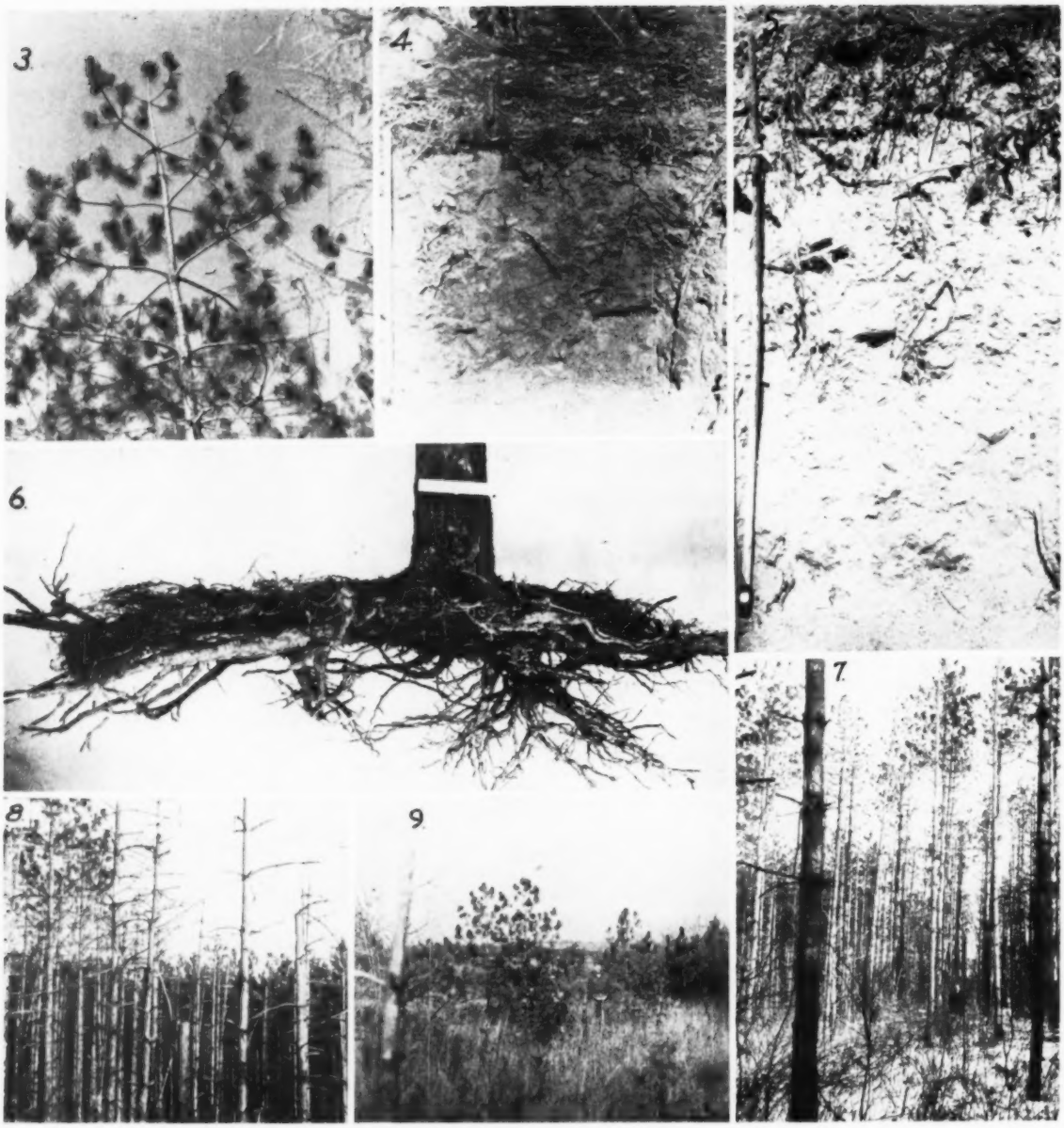

FIG. 3 9.—From red pine plantations.—*Fig. 3.* Tufted crown characteristic of conditions "A" and "B".—*Fig. 4.* Profile of a poorly drained soil, Volusia silt loam. The lateral roots do not penetrate below 12 inches and the lowermost are dead; a dense mat of fine roots occurs in the surface two inches (below the knife).—*Fig. 5.* Profile of a moderately well drained Mardin silt loam that approaches a well drained soil in its characteristics; note roots at 36 inches. From another part of same plantation as that in Fig. 4.—*Fig. 6.* Root system of a marginal tree (Fig. 2) on Volusia silt loam showing the surface mat of fine roots near the trunk. Roots deeper than 10 inches are dead. (Rule on trunk is 6 inches long.) —*Fig. 7.* Condition "A"; a 38 year old stand on Red Hook gravelly silt loam; Varna, N. Y.—*Fig. 8.* Condition "A"; a 24 year old stand on Volusia silt loam; Waverly, N. Y.—*Fig. 9.* Condition "C", transitional to "B"; a 19 year old stand on Chippewa silty clay loam; Tompkins County plantations.

Trees in conditions "A" and "B" commonly have somewhat deeper root systems with a few more or less vertical "sinker" roots immediately beneath the trunk (as in Fig. 6). Such roots often extend to depths of 18 to 24 inches. On trees remaining alive they are stubby, blackened and devoid of small laterals, with only the upper portions living. The primary lateral system is shallow and is limited almost entirely to the surface soil horizons when these are underlain by compact subsoil (Class I, Table 1) (Fig. 4). Usually only the uppermost portion of the lateral root system remains alive on the affected trees; the deeper laterals, e.g. at 5 to 10 inches, are often dead or stubby

and without fine branches for most of their length. Often there is evidence of repeated killing and regrowth of root ends, suggesting alternation of adverse and favorable growth conditions. Although no root counts were made it appears that great reduction in absorbing surface has accompanied, or preceded, development of the above ground symptoms. Long affected trees having the deeper roots destroyed may develop dense mats of adventitious roots similar in character to those of stunted trees but more extensive. Such a mat may fully occupy the surface two inches of soil for a radius of two feet and may to some degree substitute for the lack of a normal absorbing surface (Fig. 4, 6).

On areas bordering upon affected parts of the plantations, the trees usually appear outwardly healthy. In some instances, however, their root systems are restricted to the upper 10 to 16 inches of soil (Fig. 6).

Relation to Fungi and Insects

In a disease of the type here described, the possibility exists that a pathogenic fungus or other organism may be the primary inciting agent. The presence of many dead roots and rootlets on the affected trees in the areas studied suggested this. Tests were made for the presence of pathogenic fungi in the dead roots and in the soil by the method originally employed by Tucker (*30*) as modified and described by Campbell (*13*). Representative soil and root samples from affected plantations in widely scattered areas (Fig. 1) failed to yield evidence of *Phytophthora* or other related fungi.

Typical butt-rot, i.e. decay of the basal portion of the trunk and adjacent roots, was rarely observed in the areas studied. The trees remained standing after they were dead and could not be pushed over until weakened by borers and rots due to saprophytes. Attempts to isolate fungi from the roots and root-crowns of affected trees by the tissue planting method failed to produce anything of significance. *Fomes annosus* was found in two plantations but under conditions which indicated that it was not a factor in the disease under discussion.

In all the study areas, secondary bark beetles were common on dead trees, but no insects were found attacking live trees. In two plantations *Ips pini* was abundant on dead trees. Examination of tufted trees which were still green but obviously would be dead within a year or two disclosed not a single insect. Neither insects nor pathogenic fungi seem to be the cause of tree decline.

Relation to Soil Factors

Within the affected stands studied the soils ranged in texture from gravelly silt loams to clay loams and in reaction from acid (pH 4.5 surface, 5.5, subsoil) to circumneutral (pH 6 or above in surface, 6 to 7 or above in subsoil). A few lacustrine soils account for the heaviest textures and most of the high reactions noted. The majority of the soils are medium-textured and from acid materials. Inasmuch as healthy plantations occur nearby on soils similar in texture and acidity there seems to be no close relationship between these properties and growth failure.

When the soils are grouped according to their position in a drainage catena,[2] however, stunting and premature death are clearly associated with the degree of internal soil drainage. Although the soils of the affected areas represent a number of soil series, all occur in the imperfectly, poorly, and very

[2]A drainage catena consists of the several soils developed on similar parent material but differing in their characteristics because of the effects of drainage. See Fig. 2.

TABLE 1.—USUAL RANGE OF SOIL PROPERTIES IN AFFECTED PLANTATIONS STUDIED

Profile Class	Soil Materials	Drainage Level	Surface (Plow Layer) Texture[1]	Consistence[1]	Reaction[1]	Substratum Consistence	Prevalent Injury Class[2]	Representative Soil Series
I	Compact, acid or weakly calcareous glacial till	Imperfectly & Poorly Drained	Silt loams & gravelly silt loams	Friable (i.e. when moist)	Strongly to medium acid	Compact	A-B	Allis, Volusia, Fremont, Erie, Morris
		Very Poorly Drained	Silty clay loams and silt loams	Plastic (i.e. when wet)	Strongly acid to neutral	Compact	B-C	Chippewa, Alden, Norwich
II	Glacial outwash and colluvium	Imperfectly & Poorly Drained	Silt loams & gravelly silt loams	Friable	Strongly acid to neutral	Very friable to firm	A	Red Hook
		Very Poorly Drained	Gravelly silt loams to silty clay loams	Plastic	Strongly acid to neutral	Very friable to firm	B-C	Atherton
III	Glacial lake silts and clays	Imperfectly & Poorly Drained	Clay loams and silty clay loams	Very plastic	Slightly acid to neutral	Very firm when moist	A-B	Odessa, Lakemont Canandaigua
		Very Poorly Drained	Clay loams and silty clay loams	Very plastic	Slightly acid to mildly alkaline	Very firm when moist	B-C	Poygan, Toledo

[1]These terms are used as defined in the *Soil Survey Manual* (*38*).
[2]Injury classes described in the text.

poorly drained positions of a six-step catena. Conversely, these disturbances have not been found on well-drained soils (Fig. 2, 5).

The soils of the affected stands examined can be grouped into three general profile classes, described in Table 1. Soils of the first profile class, formed on compact glacial till, are by far the most common inasmuch as extensive areas of these have been abandoned for agriculture. The poorly drained members occupy gently rolling hilltops, convex and lower slopes, as well as the margins of drainage ways and seepy spots. The subsoils are very compact, with bulk densities (volume weights) commonly exceeding 1.7 and, at depth, 2.0 (*14*). Both downward drainage and root growth are greatly impeded. Excess precipitation as well as water delivered to the surface by gravel lenses and permeable rock (*12*) moves laterally along the subsoil surface. In consequence the soils, though normally dry in summer, are subject to prolonged saturation in spring and fall with water tables "perched" above the compact zone (*29*). Slope and topographic position cause some variation in the length of the saturated period in normal seasons. These soils are usually readily recognized at any season, however, by their highly mottled subsoils. The very poorly drained associates found in the drainage ways and swamp margins are moist throughout most of the year. The subsoils are heavily gleyed and mottling extends into the dark surface soils.

Soils of the second profile class are less extensive. They occur on the outwash and colluvium of lower slopes, or on mixtures of till and underlying materials that are shallow over bedrock. Usually they are characterized by pervious subsoils and their seasonal wetness is due to outward- or upward-flowing ground-water from the rock or other pervious layers beneath. Thus they may occur on steep slopes. Commonly the subsurface layers of the poorly drained soils are only finely and obscurely mottled. The very poorly drained associates resemble those on the compact till in both appearance and effect.

Only a few examples of the third profile class have been studied because such soils usually remain in agriculture. Because of the high clay content the surface horizon is often well aggregated. On level areas drainage varies from imperfect to very poor with but minor changes in relief. On steeper slopes slumping and erosion have often exposed the stiff subsoil which may be calcareous at shallow depths. The heavy textured till soil underlying a dying plantation studied by Levine and Hutchinson (*24*) is similar to the calcareous lacustrine soils of this profile class.

Almost all of the areas studied had been long cultivated prior to reforestation. Tillage destroyed the considerable micro-relief, the "cradle-knoll" topography, that originally characterized these soils. Thus in contrast to adjacent woodlands such old field sites afford few "islands" above the zone of prolonged saturation. An additional characteristic of the poorly drained sites is severe frost heaving which, under certain conditions of moisture supply and cover, may expose or deform roots.

Relation to Precipitation

Under conditions of high spring rainfall, soils with impeded drainage are susceptible to prolonged saturation and accompanying lack of aeration. The possible role of precipitation excess is suggested by the extensive root injury and evidence of its more or less simultaneous onset in all stands characterized by condition "A" and "B."

Figure 10 presents the annual radial growth of red pine in several affected areas within the Allegheny Plateau region, together with selected precipitation data from the nearest appropriate weather stations (*31*). The location of each weather station is indicated on Figure 1. The County plantation is within five miles of the Arnot station and the Varna and Ithaca Watershed plantations are within five miles of the Ithaca station. Both the Waverly and Seeley plantations are somewhat remote (*ca.* 15 miles) from the Elmira station, and the Highland Forest area is a slightly greater distance from the nearest weather station at Cortland. Because of such distances, and elevational differences as well, the station records only approximate actual precipitation at the study areas. The similarities among stations, however, indicate that the excesses and deficiencies discussed are of widespread rather than local occurrence.

Excepting data from the Varna plantation, which was established in 1914, the radial growth measurements of Figure 10 begin for the most part with the fourth year after the least advanced tree of the sample attained breast height. Accordingly the first rings measured are wide and general downward trends occur with age, particularly as the crowns close. In the Varna plantation, with trees spaced 6 x 6 feet and unthinned until 1943, the downward trend continues until 1937, with the subsequent 10 years' growth slow and uniform. A similar trend appears in the Waverly plantations, established in 1927.

For at least a decade prior to 1940, May rainfall was approximately normal or below, and at Elmira this sequence persisted until 1943. Some minor reductions in growth prior to 1940 coincide with deficiencies in total May through July rainfall, as in the years 1938 and 1939. The tri-monthly sum is an imperfect index of drought, as suggested by the 1938 value of Elmira when a dry April was followed by a further deficiency which attained nearly 3 inches by July 10, at which time it was largely reduced by subsequent excess rains. Similarly, the marked July-August deficits occurring at all stations in 1944, except Arnot, are largely unrepresented by the May through July totals.

By far the most striking feature of these curves, however, is the abrupt decline in growth of all affected trees, regardless of age, location, or soil type, beginning in 1944 to 1946 and culminating in

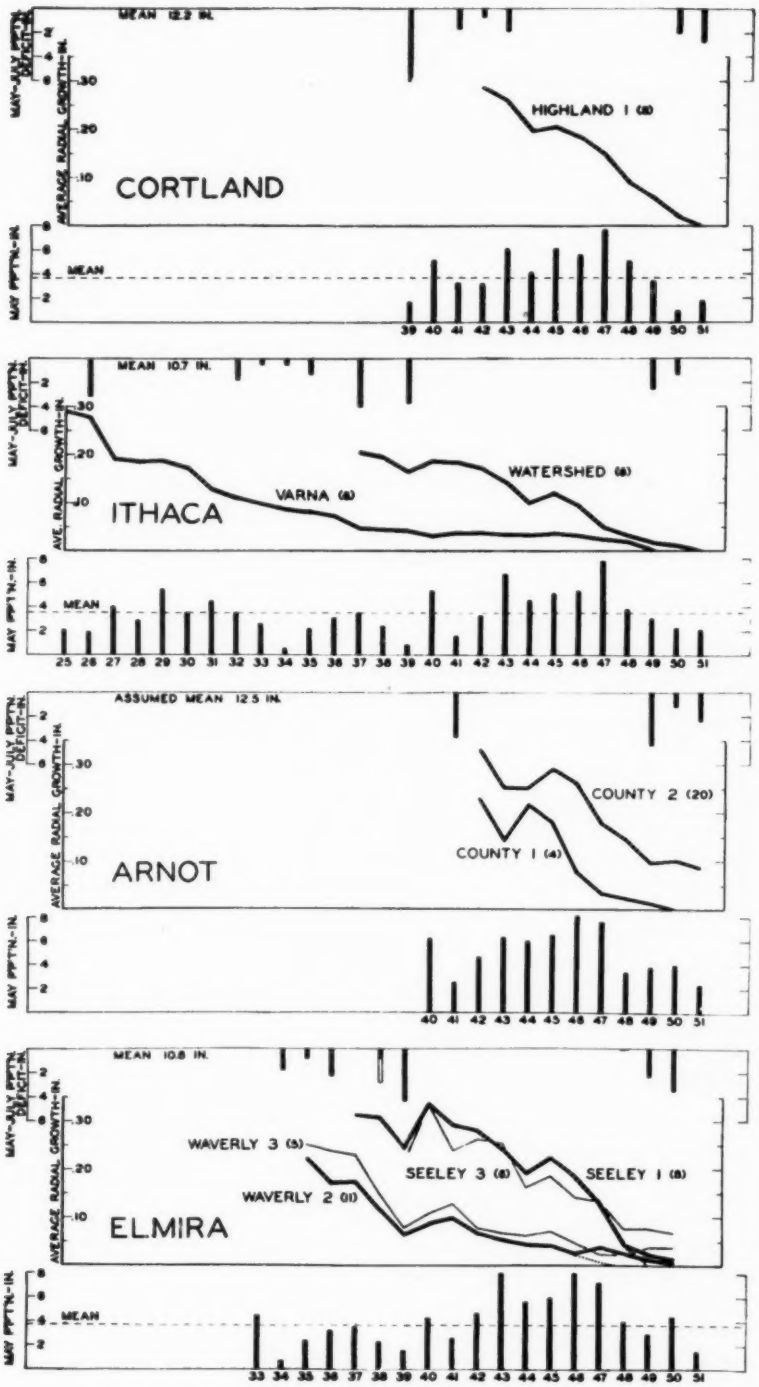
MEAN 12.2 IN.
HIGHLAND 1 (8)
CORTLAND
MAY PPTN.-IN.
MEAN
39 40 41 42 43 44 45 46 47 48 49 50 51
MEAN 10.7 IN.
WATERSHED (8)
VARNA (8)
ITHACA
25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51
ASSUMED MEAN 12.5 IN.
COUNTY 2 (20)
COUNTY 1 (4)
ARNOT
40 41 42 43 44 45 46 47 48 49 50 51
MEAN 10.8 IN.
WAVERLY 3 (5)
SEELEY 3 (8)
SEELEY 1 (8)
WAVERLY 2 (11)
ELMIRA
33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51
MAY-JULY PPTN. DEFICIT-IN.
AVERAGE RADIAL GROWTH-IN.
AVE. RADIAL GROWTH-IN.

FIG. 10.—Radial growth of affected red pine in southern New York as related to precipitation excess and deficiency at the four weather stations. (The figures in parentheses are numbers of trees measured. Dotted lines represent trees dying early. The Elmira precipitation deficit on July 10, 1938 is indicated by an open bar.)

the death or incipient death of most of the plantations represented. Dead trees were observed as early as 1946 at Varna and 1947 at Waverly. This decline appears to be associated with the unusually high late spring precipitation of the period 1943-47, shown in Figure 10 by the rainfall values for May. Marginal trees (County 2, Seeley 3) appear to have stabilized growth at a lower level for the present.

May excess was pronounced in 1943 when all stations reported 6 to 8 inches rainfall, from 2¼ to 4¼ inches above normal. June rainfall was approximately normal that year, and again following the smaller May excess of 1944, except at the Arnot station which received over 8 inches in June, 1944. The general 5 to 6½ inch May rainfall at all stations in 1945 was followed at Arnot and Cortland by some 6 inches during June. In 1946 the May excess was somewhat mitigated by April deficiencies at all stations, whereas in 1947 April excesses preceded exceptionally heavy May rainfall.

By comparison with the preceding decade, the 1943-47 sequence of May precipitation appears unusual in both duration and amount; indeed, for the state as a whole the May 1947 rainfall was the highest on record. Nevertheless, inspection of the records for Ithaca, N. Y. reveals that similar periods of May rainfall have occurred irregularly in the past, as for example in the years 1837, 1838, 1882, and 1892-4 when over 6 inches was recorded. Therefore, the 75 years of continuous record at this station were analyzed by the methods employed by Thom (*8*). It is apparent from this analysis that years with above or below normal May rainfall are distributed wholly at random, as has also been abundantly demonstrated at other localities. Table 2 gives the frequency with which years of May precipitation above certain amounts may be expected at this station, and in addition the likelihood of "runs" of consecutive years with such amounts (*15*). For convenience the frequencies are stated as the number of years the specified event can be expected in the course of a century. Precipitation frequency distributions for other stations in the Allegheny Plateau section can be expected to resemble that at Ithaca. Thus heavy May excesses, although infrequent

in human experience, must be reckoned as recurring events in the environment of a plantation which requires 40 to 80 years to attain financial maturity.

Behavior of Associated Species

Poor growth and gradual failure of white pine plantations were observed on some of the least favorable soils of the first profile class. On other soils of the first and second profile classes some instances of resin flow from the root crown and lower stem of white pine appear to correspond to the "resinosis" disease described by York (*2*). In two cases a few 30 to 35 year old Scotch pine mixed with dying red pine on poorly drained soil have also died.

No instances of dying of Norway or white spruce were noted on poorly drained soils, although the plantations observed were less than 20 years old. On a few very poorly drained sites Norway spruce exhibited poor initial survival, slower growth and somewhat chlorotic foliage. A plantation on a level area of soil of the third profile class was severely stunted.

Likewise the volunteer hardwoods among conifers are too young for full appraisal. Vigorous saplings of white ash, elm, black cherry and red maple were common on some of the more favorable of the poorly drained soils of the second and third profile classes.

Discussion

Pathogens

The affinities of the described malady with the "resinosis" disease of white and red pine named and investigated by York (*1, 2, 3, 4, 5, 6, 7, 33*) are not clear. Evidence is presented by York (*33*) that the resinosis disease studied by him was caused by an unidentified fungus. In an unpublished report (*33*) he describes two series of inoculation experiments in support of this statement. In the first of these, "more than 100 inoculations" were made on young white pine trees growing in a medium silty soil, having good surface and underground drainage. Five years after inoculation, one of the trees showed an extension of the original lesion of "more than an inch" and this tree was considered to be infected. In the second series, 50 trees were inoculated. Four years later all showed marked infection and abundance of resin, and two were in a dying condition, with their root crowns completely girdled. The second lot of trees was growing in a fine heavy silt, with fair surface drainage and very poor underground drainage. The relation between poor soil drainage and the occurrence of the disease is further indicated by the following quotation from York (*33*:p. 22) referring to the second lot of inoculated trees mentioned above. "The writer believes that if the trees in Lot B had not been inoculated they would eventually have had resinosis since there was an adjacent white pine plantation where the trees were about 28 years old and many of them had resinosis. The pH and physical properties of the soil in these two plantations were almost identical."

TABLE 2.—CHANCES OF SINGLE AND CONSECUTIVE YEARS WITH MAY PRECIPITATION EXCEEDING GIVEN AMOUNTS AT ITHACA, N. Y.; EXPRESSED AS NUMBER OF YEARS PER CENTURY EXCESS MAY OCCUR. (AVERAGE MAY PRECIPITATION = 3.47",[1] MEDIAN = 3.25")

May precipation greater than:	Number of consecutive years: 1	2	3	4	5
Inches	*Years per century*				
4	33	22	7	2	1
5	18	14	3	<1	
6	9	8	<1		
7	4	4	<1		
8	2	2	<1		

[1]This value, based on the 77-year record from the Cornell campus compiled by W. K. Widger, Jr., differs slightly from the Weather Bureau normal used in Figure 10.

The predisposing effect of poor underground drainage on the susceptibility of pines to the resinosis disease is mentioned repeatedly in the report. Finally, York concludes that "— if the pH of the soil was a factor in predisposing the trees to disease, it was secondary to the high percentage of colloidal material and soil structure (*33*:pp. 35, 36)." It may be added that "structure" referred principally to the compactness of subsoil. Also, "colloidal material" (silt plus clay, by the Bouyoucos method), although often higher in the surface of very poorly drained soils, does not in fact bear any close relationship to soil drainage. However, York's description of soil mottling, subsoil compaction, perched water tables and hypertrophied lenticels clearly indicates that he associated the disease with some degree of impeded soil drainage. This is further borne out in other reports published by him on the resinosis disease. (*2, 3, 4, 7*).

York's area of study embraced a range of conditions. Present observations on a few red pine plantations within these areas indicate that the soils and growth conditions associated with dying of this species differ in no respect from those occurring elsewhere, as reported in this paper.

Ibberson (*23*) in a preliminary account of a diseased condition of red pine in southeastern Pennsylvania reported the fungus *Phytophthora cinnamomi* associated with the roots of affected trees. The symptoms described indicate that the onset of the attack is more sudden than that observed in the red pine disorder reported in this paper. Abnormal reduction in size of the terminal shoot occurs in the first year and the next year the tops of the trees wilt, bend over, and die. These symptoms are usually followed by insect attacks although many affected pines gradually die without any attack by insects. The ability of the fungus *Phytophthora cinnamomi* to cause the disease was not tested by inoculation experiments. The observation was made that trees growing on the lowest, poorest-drained soils were the first to die. The comment was also made that red pine in the area studied was south of its natural range and, under these circumstances, the future of the plantation was doubtful.

Spring precipitation at many stations in southeastern Pennsylvania was abnormally high in 1946-48, (*31*) however, and the observations of the present paper suggest this may also be of significance.

Copeland (*17*) has demonstrated a relationship between soil drainage level and the incidence of "littleleaf" disease in loblolly and shortleaf pine. Present information on this disease suggests the action of a root pathogen influenced by soil conditions, and there is considerable evidence linking *Phytophthora cinnamomi* with the occurrence of dead roots. It was found that as the internal drainage of the soil became poorer the percentage of littleleaf increased.

In the foregoing reports the part played by pathogenic organisms is not yet clearly resolved. Moreover, in the present malady, attempts to isolate a pathogen have been unsuccessful. In particular, *Phytophthora cinnamomi* was not found nor was *Fomes annosus* excepting the two unrelated occurrences noted.

Soil Drainage and Rainfall

Internal soil drainage is significant for plant growth chiefly through its effects upon soil aeration (*32*). Under conditions of prolonged soil saturation the oxygen content of the deeper soil layers is reduced to very low levels. Commonly, a reduction in oxygen content during the winter and early spring is an annual occurrence on soils such as those of Table 1, and under the influence of heavy spring rainfall the oxygen deficiency may persist well into the growing season. Hence excess spring rainfall is of particular significance, and Boynton (*10*) suggests that "an excess of only a few inches of precipitation in May and June may have a far greater depressing effect on the air supply of the subsoil than will an excess twice as great occurring in September."

The consequences of soil aeration upon root development are generally understood (*27*). In the apple, for example, roots are able to survive at rather low oxygen concentrations but with impaired effectiveness (*9, 11*). Successively higher oxygen levels are required for growth of existing root tips and for initiation of new roots.

In the absence of physiological studies of forest trees their natural occurrence is often studied as a clue to their growth requirements. In nature red pine occurs only on well drained or excessively drained soils (*16*). Quite unlike white pine, the species is rarely or never found on poorly drained soils despite the suitable seedbed conditions occasionally afforded through exposure by wind or fire. In decided contrast to natural stands, all of the affected plantations observed occur on soils classified as imperfectly, poorly or very poorly drained. These several considerations, together with evidence of massive root destruction in the absence of primary pathogens, strongly suggest deficient soil aeration as the major factor involved in the death and stunting of red pine plantations.

According to this view the stands currently affected were favored by a long sequence of near-normal or below-normal May precipitation, a sequence that at Ithaca endured from 1920 to 1939 with but one exception in 1929. (Fig. 10). Moreover, these stands, most of which were planted in the 30's, were youthful and perhaps capable of recovering from such injury as did occur, except on very poorly drained soils where continued stunting resulted. Even the appreciable May excess at some stations in 1940 may have had little lasting effect. In 1943, however, and repeatedly from 1945 to 1947 heavy May and May-June rainfall caused prolonged soil saturation and often led to killing or partial destruction of all but the shallowest roots. Possibly some regeneration of the absorbing surface occurred following the initial killing but this too was largely eliminated in subsequent years. Thereafter gradual appearance of above ground symptoms and death were inevitable. Trees somewhat less severely affected remain alive for the present but with shallow root systems that restrict their growth and leave them in hazard from drought and future soil saturation, as well as from windthrow. Copeland's (*18*) observations on shortleaf and loblolly pines, indicating "a critical percentage of dead roots somewhere between 18 and 34 percent beyond which a tree fails to continue normal growth and begins to decline," are of interest here. So also are the results cited by Hunt (*22*) demonstrating that the tops of pine seedlings remain outwardly unaffected for at least some months after severe injury to the roots produced by flooding.

The lag in visible effects makes it impossible to determine whether a single year of very excessive spring precipitation could have consequences comparable to those following the 1943-1947 sequence. Marked diminution in growth occurred by 1946 in most trees measured, and a year earlier in some, suggesting major root destruction by that time. Dying trees were observed as early as 1946 and 1947 in two plantations, indicating culmination of injury prior to the 1947 record rainfall. It seems likely that very young stands might be capable of regenerating root systems following a single year's injury but that older plantations, of whatever density, would be severely injured.

Further, examination of the Ithaca weather records demonstrates that both single years and successive years of excess May precipitation are simply random events that may be expected to recur in the future. As with climate, the influence of the soil upon a long-lived plant must be appraised in terms of the extremes presented, as well as the "average" conditions, particularly when the extremes may have lethal consequences. Thus soil saturation and accompanying oxygen deficiency persisting well into the growing season must be considered normal, although not annual, environmental characteristics of the less well-drained soils. Trees incapable of withstanding such fluctuations are clearly poor choices for timber production on such soils.

Silvicultural Recommendations

The results of this survey help to evaluate possible means for preventing such growth failures.

Mechanical measures. — Diversion ditches, drains and furrows are possible means of removing surface water and intercepting surface flow, although presumably not of practical significance except under special conditions. Such means are most likely to prove helpful on sloping soils of the first profile class where a subsurface flow at shallow depths often may be intercepted; on these some measure of drainage often results from interception by road ditches, gullies or long-buried stone drains. Thus on the Highland Forest construction of a new road cut off subsurface flow with the result that "tufted" red pine immediately below the road now show evidence of slow recovery where those above continue to die.

Cultural measures.—There is no evidence indicating that thinned stands are less susceptible to injury than dense stands, although some foresters have acted upon this belief. Stand density cannot affect soil saturation to any appreciable degree and the only effect possible would be in the opportunity for recovery. This does not appear to be of consequence in the several understocked and thinned stands affected by the malady, suggesting that an investment in plantation thinning is more likely to be profitable on well drained soils.

Site classification and recognition. — The most useful measures are to recognize and avoid hazardous planting sites. Suitability for red pine can be determined from easily recognized characteristics indicative of drainage or from detailed soil maps when properly interpreted. In contrast to the characteristics of poorly drained soils, the well drained acid soils of southern New York are usually relatively "bright" yellow brown, reddish brown or brown in color beneath the plow horizon and lack any evidence of mottling within the upper two feet (Fig. 2).

In several counties, modern soil surveys have been completed with maps at a scale of 2 inches to the mile, affording a wealth of detailed information. For simplicity in evaluating their suitability for red pine the numerous soil types can be grouped into three classes, suitable, uncertain, and hazardous on the basis of drainage level and alkalinity, irrespective of other soil properties. Accordingly, well drained and excessively drained soils are classified as suitable for red pine whereas the poorly and very poorly drained clearly are not. A portion of such a classification based on a recently completed survey of Allegheny County, N. Y. (*26*) is shown in Table 3. The moderately well drained soils are classed as uncertain or doubtful, allowing final decision in the field on the basis of topography, erosion or other features. For the present all soils slightly acid to alkaline in the surface and neutral to alkaline in the subsoil are considered unsuitable in accord with general silvicultural belief (*25*), although the supporting evidence is not rigorous.

These classes serve as a key for determining red pine suitability of a given area from a conventional soil survey map. Alternatively, an auxiliary "suitability map" can be prepared with only the three classes represented, as in Figure 11. For this purpose an uncolored soil survey map is used as a base and the soil types composing each of the three classes are grouped and colored alike. Green, amber and red are appropriate colors.

These classes are broad, ignoring factors such as slope and previous erosion that may influence ultimate growth rate and yield. Neither do they consider extremes of steepness, shallowness, erosion, etc., that might indicate a species other than red pine, although such extremes are uncommon in the plantable areas. Within the boundaries of a given soil type as represented on the map there may be inclusions of other types too small to be separated. Similarly, local relief and modifications of drainage by roads, etc., cannot always be appraised from the map. For these reasons no map of this scale should supercede well informed decisions made in the field; at the very least, however, such a map will facilitate decisions and may considerably improve their quality.

In the example given the "suitability" classes may seem conservative inasmuch as outwardly healthy young stands are still common on some of the soil types classified as hazardous because of

TABLE 3. — SOME COMMON SOIL SERIES OF ALLEGHANY COUNTY, NEW YORK, ARRANGED ACCORDING TO CATENA AND DRAINAGE LEVEL, IN RELATION TO THEIR SUITABILITY FOR RED PINE

Acid Soils						Alkaline Soils
Drainage Level						(All Drainage Levels)
Excessive	Well	Moderate	Imperfect	Poorly	Very Poorly	
Lordstown	Bath	Mardin	Fremont	Volusia	Chippewa	
Oquaga	Cattaraugus	Culvers		Morris	Norwich	
Manlius			Hornell	Allis	Chippewa	
	Chenango	Braceville		Red Hook	Atherton	
	Tunkhannock	Braceville		Red Hook	Atherton	
			Langford	Erie		
	Tioga	Middlebury		Holly		
Suitability for Red Pine:	Suitable	Uncertain		Hazardous		Hazardous

drainage. Very possibly a number of these may continue to escape the more drastic consequences of recurring soil saturation and reach merchantable size but with increasing losses from windthrow and growth reduction.

It should be added that York (*4*) had strongly emphasized the adverse effects of compact subsoils, independent of soil reaction, on plantations of both red and white pine in the Southern Tier counties. Likewise, Diebold (*20*) had noted the association between wet soils and poor survival of various conifers, including red pine. In Michigan, Day (*19*) found red pine rooting shallowly on a poorly drained sandy soil. Littlefield's summary (*25*) directs attention to the various factors, including soil drainage, involved in planting-site selection for red pine.

Thus the evidence at hand indicates that red pine is a poor risk on all except reasonably well drained soils.

Summary

Stunting and dying of red pine plantations occurring locally in southern New York are described. These disturbances cannot be attributed to primary pathogens or insect attack but are consistently associated with impeded soil drainage. The recent increase in plantation mortality on poorly drained soils follows a series of years with unusually high May rainfall.

The relationship between soil drainage and mortality is thought due to root injury resulting from deficient soil aeration, particularly during long periods of saturation in the spring. Analysis of the May precipitation record at Ithaca, N. Y. indicates the random but recurrent nature of years with high spring rainfall and hence the position of prolonged soil saturation as part of the normal root environment of a long-lived plant on poorly drained sites.

Cultural methods appear ineffective and the only practical method of avoiding injury is by proper planting site selection. An illustration of grouping soil types according to suitability for red pine is given.

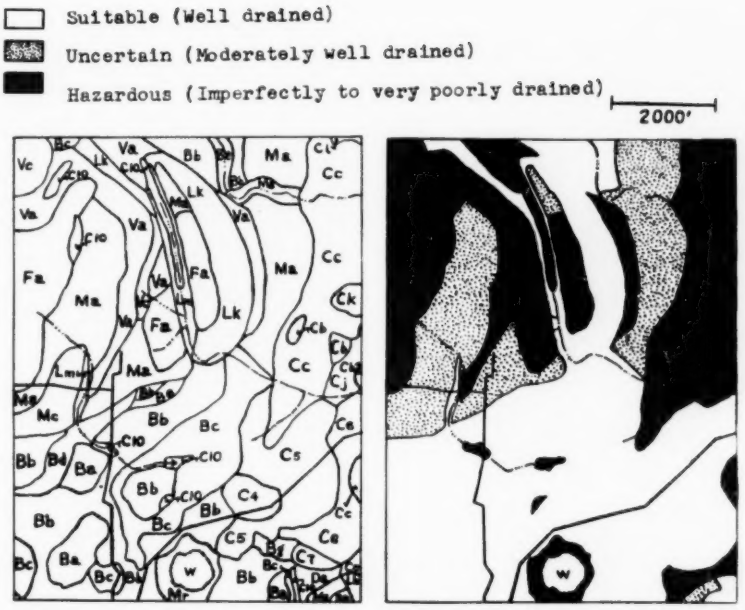

FIG. 11.—*Left*: Soil survey of portion of town of Hume, Alleghany County, N. Y. (*26*). The symbols represent mapping units composed of soil, slope and erosion class. *Right*: The same area with the units combined according to suitability for red pine.

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Coming Events

Upper Mississippi Valley Section

The Upper Mississippi Valley Section will hold its winter meeting in St. Paul, Minn. Feb. 12-13.

Allegheny Section

The Allegheny Section will hold its winter meeting in Baltimore, Feb. 25-27.

North American Wildlife Conference

The 19th North American Wildlife Conference will be held in the Palmer House, Chicago, March 8-10.

New England Section

The New England Section will hold its winter meeting at the Hotel Somerset, Boston, March 11-12.

Forest Products Research Society

The 1954 meeting of the Forest Products Research Society will be held in Grand Rapids, Mich., May 5, 6, and 7, under the direction of Fred E. Dickenson, national meeting chairman.

Gulf States Section

The Gulf States Section will hold its spring meeting at Lake Charles, La., May 6-7.

Ozark Section Meeting

The winter meeting of the Ozark section will be held in the Lafayette Hotel, Little Rock, Ark., Feb. 5-6.

The Stimulation of Loblolly Pine Seed Trees by Preharvest Release[1]

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The large increase in cone crops often observed on loblolly pine trees isolated by cutting suggested that releasing selected trees from direct competition several years before a scheduled reproduction cutting might make ample quantities of seed available immediately after cutting, improving the chances of satisfactory regeneration. In this study the response of such released trees in flower bud formation was immediate, marked, and protracted, and their seed production was judged sufficient to regenerate a stand satisfactorily.

THE LARGE yearly variation in cone crops is a serious obstacle to successful even-aged management of loblolly pine. In poor crop years the amount of seed produced by whatever seed source is left may be insufficient for satisfactory stocking of reproduction, and the seed fall in following years can seldom be relied upon to increase stocking to a satisfactory level (*11*). Jemison and Korstian (*4*) have pointed out that a succession of poor seed crops, although they may be numerically equal to one good crop, are not so effective in obtaining a desired level of seedling stocking. Trousdell (*11*) recorded milacre stocking of loblolly pine seedlings in seed-tree and strip cuttings that were made during the five years from 1946 to 1950, and found that five of six tracts clear-cut to seed trees in the poor seed years of 1948 and 1949 had not restocked satisfactorily even though the 1950 seed crop was much better. The one that did restock had been disked before logging and all residual hardwoods over 5 inches d.b.h had been poisoned. On this tract in the first year after logging eight sound seeds were required for the establishment of one seedling but by the second year the requirement had risen to 40 seeds per seedling. Four tracts cut in 1946 and 1947, when a good and a bumper seed crop were produced, restocked satisfactorily even though subsequent seed crops were very poor.

This evidence indicates that successful loblolly pine regeneration in the Southeast depends on first-year seeding and not upon accumulated seeding over a longer period. Germination and initial establishment of loblolly pine are much greater on mineral soil than on undisturbed litter (*3, 6, 8*), and clear-cutting exposes mineral soil on large portions of a logged area. Tractor logging exposes mineral soil on as much as 50 percent of the logged area, and good seedbed conditions may be created on as much as 80 to 85 percent of the area if it is also burned or disked (*8*). These favorable conditions apparently deteriorate rapidly after cutting with the accumulation of litter from residual hardwoods, sprouts, and herbaceous vegetation, so that a greater amount of seed is needed with each passing year to produce a specified level of stocking.

The tendency of loblolly pine to increase cone production after release may offer a way to overcome the obstacle of cone-crop variation. Barrett (*1*) observed a 100-percent increase in cone crop after partial cutting. Chapman (*2*) states that residual loblolly pines in cut-over areas enormously increase their seed production over similar trees in uncut stands. If selected trees released several years before a scheduled clear-cutting could be relied upon to increase their seed production substantially, larger amounts of seed could be made to coincide with a fresh seedbed and the chances of satisfactory regeneration would be greatly improved. A study was begun in southeastern Virginia in 1947 to determine whether loblolly pine trees would respond sufficiently to preharvest release to justify further investigation of the method.

Procedure

Three old-field stands of loblolly pine on two separate tracts were chosen for the study. The stands were 27, 33, and 43 years old and the site index was 80-85 feet.

One hundred and fifty-six vigorous, well-formed, dominant and codominant trees were selected at intervals of 50 to 60 feet. The choice was limited to trees that were uniformly confined on all sides so that the degree of release would be similar for all treated trees. Trees were paired according to their similarity in diameter, height, width and length of crown, age, and size of current cone crop. The one of each pair to be released was chosen by a coin toss.

Enough competitors were cut around each selected tree to give it growing space equal to 2½ to 3 times its crown width which resulted in a 20-foot radius, on the average, being cleared around each released tree. The release cutting was made during the winter of 1946-47 and produced an average of 1.32 standard cords of pulpwood for each released tree.

Cones on the standing trees were counted with binoculars every year from 1946 till 1951. Counts made during the first 3 years showed significantly greater cone crops on released trees, although release could not have affected cone production before the fall of 1949. Two growing seasons are needed for cone development, and flower buds must first be formed. Apparently many cones were missed in counting because crowns of control trees could not be seen clearly. Beginning in 1949, therefore, about one-third of the trees, equally divided between released and control, were cut each year and exact counts of sound and defective cones were made. The differ-

[1]This study was planned and installed on lands of the Camp Mfg. Co., Inc., Franklin, Va., by K. B. Pomeroy and I. H. Sims, of the North Coastal Plain Research Center, Franklin. All cutting was done by the company.

[2]Forest Service, U. S. Dept. Agric.

ences between binocular counts and these exact counts were used to correct the counts made in previous years.

Two sound cones were taken from each felled tree in 1950 and 1951, the seeds were extracted and cut, and sound and defective seeds were counted.

Effect of Release

The trend of annual cone crops for the period of the study is shown in Figure 1. The values include both sound and defective cones. The treatment effect is expressed more accurately by the total number of cones than by the number sound because the intensity with which growing cones are attacked by insects or other agents is independent of the flowering induced by treatment.

As would be expected from the length of time required for flower bud formation and cone development, the small differences between crops of released and control trees before 1949 were not significant. From 1949 on, the differences were highly significant.

The release cutting in the winter of 1946-47, therefore, was immediately effective; that is, it caused an increased number of flower buds to be formed during the first growing season after cutting. This case is not an isolated one, for a similar third-year increase had been observed in a shelterwood cutting (*7*), in two strip cuttings (*9*), and in two seed tree cuttings (*12*). Residual trees in the Bigwoods Experimental Forest (near Franklin, Va.), whether in seed tree, strip, or shelterwood cuttings, have invariably produced larger seed crops in the third growing season after cutting when cutting was done during the dormant season (*11*). Stands cut during the growing season showed the effect of release in the third or fourth crop after cutting, depending on whether they were cut early or late during the season. The critical period seems to be sometime during late June or July, probably varying considerably from year to year. It may be safe to say that the third succeeding cone crop will show an increase if trees are released before the end of May.

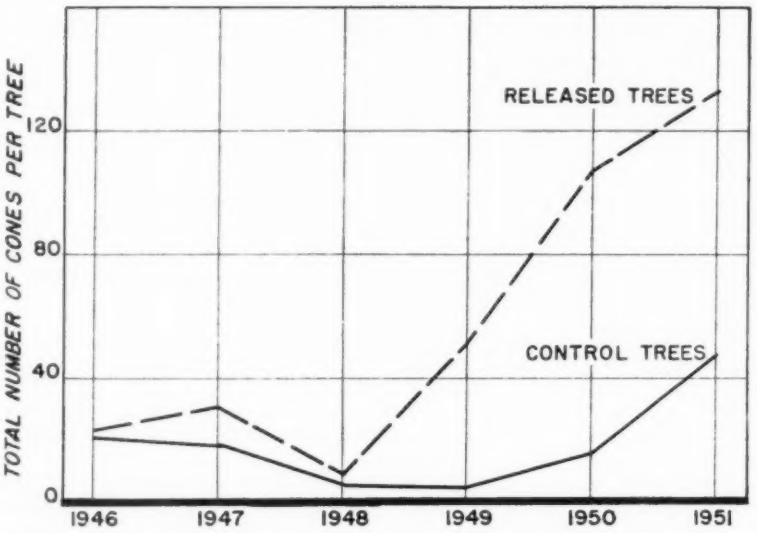

FIG. 1.—Trend of annual cone crops of released and control trees. Release was performed in the winter of 1946-47.

Also noteworthy is the fact that the increase in cone crop caused by release in this study occurred in a very poor seed year, as shown by the crops on control trees and by other data (*10*). The third-year increase of the two strip cuttings reported by Trousdell (*9*) also came in a poor seed year. The third-year increase apparently can be expected with confidence regardless of the general trend of cone crops in uncut stands, although the increase may not be so great in poor as in good seed years.

A third result revealed by the trends in Figure 1 is that the effect of release carried over to the fourth and fifth year. Protracter response would introduce some flexibility into the pre-harvest release method, since the harvest cutting would not necessarily have to be made during the first year release was effective. It should be pointed out, however, that in this case the improvement in cyclic factors may have contributed to the increased production of the released trees in 1950 and 1951.

Release did not affect the percentage of cones attacked by insects, the total number of seeds per cone, or the percentage of seeds that were defective. Cone losses averaged over released and control trees amounted to 33 percent. The average number of seeds per sound cone was 87, of which 36 percent were defective.

Tree Size and Fruitfulness

Pomeroy (*5*) found that cone production by released trees after a period of 15 years was strongly related to their diameter and cone production at the beginning of the period. Other characteristics, such as total height, crown size, and crown ratio, were not consistently related to future productivity. Although the period covered by this study was much shorter, the immediate and marked response to release and the greater precision of observation suggested that these data might yield more refined relationships. Past performance of each tree was expressed by the average of the three crops produced before release was reflected in cone production (1946 to 1948) and the diameter used was that at the time of installation.

The relations derived from these data differed only slightly from those obtained by Pomeroy. In the present study, diameter and previous fruitfulness were found to be alternative rather than complementary indicators of cone production after release; previous fruitfulness was the better of the two. That is, each variable alone was

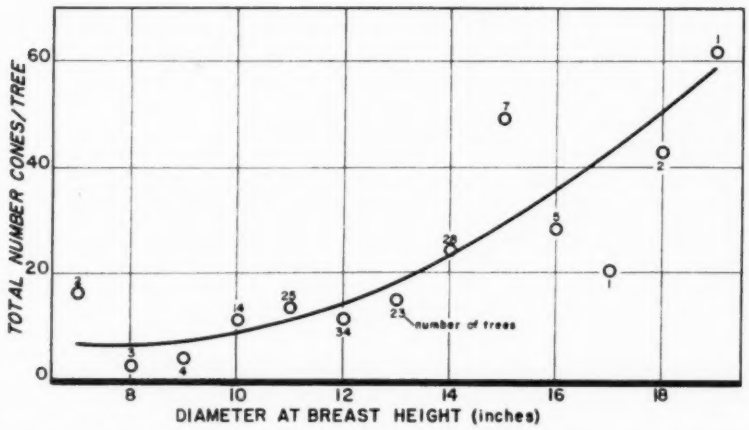

FIG. 2.—Relation of the total number of cones to the diameter of the tree before release.

significantly related to cone crop after release but with the two in combination only previous fruitfulness was significant. The explanation for this behavior lies in the fact that these two variables were themselves closely related. The strong relationship shown in Figure 2 is similar to that found by Barrett (*1*).

Although diameter was not so good an indicator of production after release, it should probably also be considered in choosing the trees. Large cone crops can be produced only if ample crown surface is available for cone bearing; consequently, small-crowned trees cannot be expected to produce large crops, even though their response to release may be relatively great. Diameter has another virtue in this connection in that it is easier to measure or estimate than past cone production.

The most reliable method of choosing the most fruitful trees, then, is to pick the larger trees which also show evidence of fruitfulness by the presence of old cones in the crown. Where the choice lies between trees of about equal diameters, the one with the greater number of old cones should be chosen; where the choice lies between trees with about equal numbers of old cones, the one of larger diameter should be chosen.

The relationships presented in Figure 3 reveal another characteristic of loblolly pine fruiting behavior. Trees produced cones more nearly in accordance with their fruiting ability under favorable than under unfavorable conditions. As cyclic factors improved (poor to good regional crops from 1949 to 1951), the control trees became more distinctly segregated by fruiting capacity, as the increasing slopes of the regression lines show. Discounting the lack of a relation among released trees in 1950, which was attributable to a single exceptionally responsive tree, this behavior was even more marked under the added influence of release.

Effect of Preharvest Release on Seed Tree Requirements

How many released trees would have been needed to give a reason-

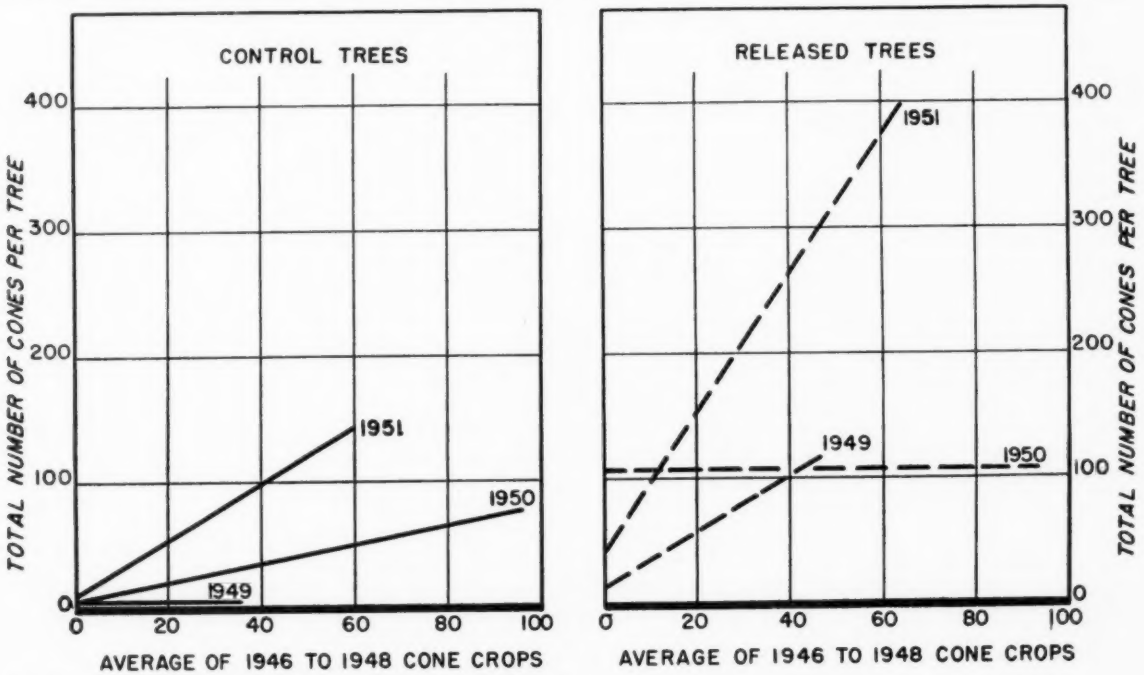

FIG. 3.—Relation of observed cone crops to previous fruitfulness.

able assurance of satisfactory regeneration immediately after cutting? In 1949, one of the poorest seed years on record, 4 to 13 released trees that had previously borne 30 or more cones per year and were 15 inches or more in diameter at breast height would have produced enough seed for satisfactory stocking. This conclusion was reached by relating the sound cone and seed production from released trees of different diameters and fruitfulness to the seed requirements for first-year seedbeds found by Trousdell (*8*). Since the purpose of the study was to explore the possibility of overcoming the obstacle of poor seed years, the 1949 data were most pertinent. Cone production in 1949 was very poor throughout eastern Virginia and North Carolina (*10*). The results of the computations are presented in Table 1.

These seed-tree requirements obviously extend beyond practical limits. If an average radius of 20 feet is cleared around each selected tree, as in this study, to leave 35 trees per acre would require cutting all others. The undesirable consequences of clear-cutting — rapid hardwood development and seedbed deterioration — that preharvest release is designed to overcome would follow. Preharvest release therefore is limited to the more usual practice of leaving 4 to 12 seed trees per acre.

Approximately that number of seed trees would have produced enough seed for 90 percent milacre stocking on the disturbed portion of a logged tract (Table 1). The same amount of seed would have resulted in about 50 percent stocking on the undisturbed portion. If the area had been burned, that amount of seed would have produced about 75 percent stocking on the burned portion. It is evident, therefore, that preharvest release is quite promising as a method of overcoming the obstacle to successful loblolly pine regeneration imposed by poor seed years. It merits further study, and pilot-plant trials have been started.

TABLE 1.—NUMBER OF RELEASED LOBLOLLY SEED TREES NEEDED PER ACRE FOR 90 PERCENT MILACRE STOCKING IN A POOR SEED YEAR (1949)

Seed tree characteristics			Type of seedbed		
Fruitfulness before release, 1946-1948	D.b.h.	Fruitfulness after release, 1949	Undisturbed	Burned	Disturbed
No. cones	*Inches*	*No. cones*	*No. trees*	*No. trees*	*No. trees*
10	10.5	37	75-108	30-36	15-28
30	15.2	80	34- 49	14-16	7-13
50	17.9	124	20- 29	8-10	4- 7

Summary

Seventy-eight trees were released in the winter of 1946-47 by giving them growing space of 2½ to 3 times their crown width and an equal number of similar trees were chosen as controls. Cones were counted on standing trees, with binoculars, in 1946, 1947, and 1948. Beginning in 1949, the first year that release could be effective, about one-third of the trees were cut each year and exact cone counts were made. A sample of two cones was taken from each cut tree to furnish seed production data.

In 1949, the initial year that release could be reflected in mature cone production, and an exceptionally poor seed year, released trees produced 51 cones per tree, a highly significantly greater number than the 5 cones per tree produced by control trees. The highly significant effect of release extended to 1950 and 1951, released trees producing 107 and 132 cones per tree compared to 16 and 48 cones per tree produced by control trees.

Release had no effect on percentage of cones defective, total number of seeds per cone, or on percentage of seeds not viable.

The cone crop after release was predicted with greater accuracy by the previous cone crop than by diameter at breast height. Previous fruitfulness and diameter were closely related.

The estimated seed production of the released trees in the poor seed year 1949 was compared with the seed requirements for obtaining 90 percent milacre stocking of reproduction on the disturbed portion of a seedbed in the first year after logging. Four to 13 trees, 15 inches or more in diameter at breast height that had previously borne 30 or more cones per tree, probably would have produced that stocking. It was concluded that preharvest release is a promising method for overcoming the obstacle of poor seed years and merits further study.

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Mechanical Aspects of Wind-Breakage and Windfirmness

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Storm damage in a forest is apparent to every woodsman, but the fundamental behavior of trees under wind stress requires detailed study. Of the many effects that wind has on trees, only the mechanics of breakage and blowdown of healthy trees are considered in this paper.

ACCORDING to the reappraisal of the forest situation conducted by the U. S. Forest Service in 1948 (*14*), losses caused by windstorm and agencies other than fire, insects and diseases account for 2.5 percent of the annual drain on the saw timber resources of this country. This loss actually exceeds that from fire, which is 1.6 percent of total drain. Damage by wind is undoubtedly the most important of these miscellaneous causes of loss. The catastrophic losses caused by spectacular windstorms in the Northeast and the Pacific Northwest during recent years are probably equalled in importance by the insidious damage which is constantly occurring throughout the forests of the country. The means of reducing this loss, however limited they may be, are primarily silvicultural and must rest upon a knowledge of the mechanical factors which cause trees to be resistant or susceptible to windfall. In this article the literature on some of these factors is reviewed and related to observations made on the Eli Whitney Forest, near New Haven, Conn.

Strong winds can break a standing tree only when the resisting and holding strength of the roots is greater than the strength of the bole. Uprooting, on the other hand, occurs when the strength of the stem is greater than that of the roots and the latter are not strong enough to support the tree. Investigations of the strength properties of green wood of conifers and broad-leaved species have shown very clearly that strength in tension is much greater than strength in compression. The magnitude of this difference is shown on Table 1, which is drawn from data of Markwardt and Wilson (*6*) on the strength of some of the more important conifers. These data indicate that the woods of these representative conifers are roughly three times as strong in tension parallel to the grain as they are to compression in the same direction. This difference between strength of green wood in tension and compression is a major factor in wind damage.

There are three main categories of natural protective adaptations of trees against stress imposed by the force of wind. The distribution of wood in the stem may be modified, the anchoring of the tree in the soil may be improved, and the shape and size of the crown may be altered so that the area on which the force of the wind may act is reduced. This paper deals with the first two kinds of adaptation.

Effects of Wind On Stem Form

During a wind storm the tip of a tree crown oscillates in an elliptical pattern, the major axis of which is in the direction of the wind. Therefore, all sides of the stem and root ball are put under stress alternately during the rotation. The most critical stress is applied on the leeward side of the tree. Loading on the windward side results from the backward swing of the stem. Schwendener (*12*) stated, as early as 1874, that large, well-formed spruce stems approximate beams of uniform resistance. Metzger (*8, 9*), who continued the work of Schwendener on the mechanical principle of tree structure, maintained that a tree must use its growth to achieve a maximum of strength against windbreakage with a minimum of material. The theory that a bole, especially in conifers, nearly always satisfies the requirement of a beam of uniform resistance to bending has been confirmed and supported by many later workers (*2, 11, 15*). If a force is applied at the free end of such a beam, the resulting stress in the outer fibers is constant all along the length of the beam. For a beam of circular cross section the unit stress S in the outer fibers at a distance x from the free end is:

$$S = \frac{32\,Fx}{\pi\,D_x^3}$$

when a force F is applied at the free end; D_x is the diameter at distance x from the free end. If S_a is the maximum allowable unit stress without failure, the above equation may be written:

$$\frac{\pi\,D_x^3}{Fx} = \frac{32}{S_a}$$

in which the right member is constant. The quantity Fx is the bending moment at a distance x from the free end. For any given force D_x^3 is linear in terms of x. A tree

TABLE 1.—STRENGTH PROPERTIES OF FOUR NORTH AMERICAN SPECIES, PARALLEL TO THE GRAIN, TESTED IN THE GREEN CONDITION

Species	Ultimate tensile strength	Maximum crushing strength
	Pounds per square inch	
Douglas-fir (coast type)	12980	3890
Western Hemlock	9860	2950
Loblolly pine	11570	3490
Sitka spruce	8110	2670

[1]This work was carried out while the author was a student at the Yale School of Forestry, New Haven, Connecticut. The author wishes to express his appreciation to Professors D. M. Smith and F. F. Wangaard for their guidance in the research and in revising the manuscript.

[2]Forest Service, U. S. Dept. Agric.

exposed to wind approximates a cantilever beam of constant strength with the force acting at the center of gravity of the crown.

The cambial cells are placed alternately under pressure and tension when the tree is bending, and growth at any point is accelerated in proportion to the degree of bending (*2*). The greatest stimulation in the cambial layer occurs naturally in the direction of the prevailing wind. Jacobs (*4*) observed that trees which are exposed to wind mostly from one direction put on uneven annual rings, so that the normally cross sections are altered to ellipses with the long axes parallel to prevailing winds. This form of adaptation to additional strength requirements can be observed easily on cross sections of trees which grew along the border of a stand.

Jacobs (*5*) also carried out experiments to determine the effect of sway upon tree growth. He compared the stem and root growth of normal young *Pinus radiata* and *Eucalyptus gigantea* trees with the growth of those stabilized by guy-wires. Measurements of the increment showed that prevention of sway caused a marked reduction in diameter growth in the guyed part of the bole and in the roots of both species.

Volkert (*15*) argued that, since static factors result in the stimulation of the cambium and thereby influence the distribution of the wood volume, this same stimulus might well influence the density of the wood. He found confirmation of his hypothesis in pine stems of cylindrical form, where the lack of wood volume was compensated for by correspondingly higher specific gravity in those parts of the stem concerned.

Bryant (*1*) reworked some of Volkert's data to check the assumption that the bole of a tree is a beam of uniform resistance to bending. On the assumption that strength is a straight-line function of specific gravity, he found that the lower 6 feet of Volkert's trees were stronger than the theory of uniform resistance to bending would indicate. However, this assumption is not always sound and Bryant therefore suggested that the displacement of the fibrils from the vertical at the base of the tree might be sufficiently weakening to require a thick butt to fulfill the theory of uniform resistance to bending.

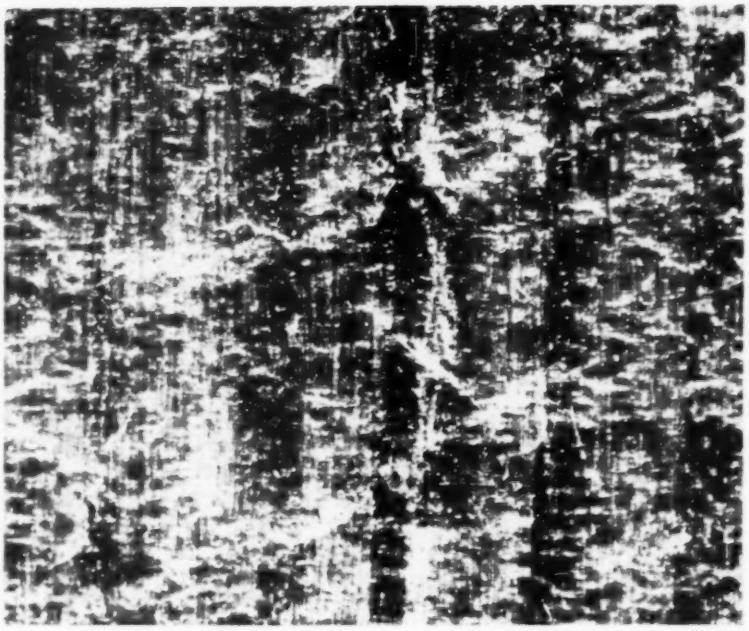

FIG. 1.—Photomicrograph of initial compression failures in red pine. The lines of failure (white lines) extend obliquely across a tangentially split surface. The dark vertical lines are the summerwood portions of the annual rings. (Photographed under oblique light. X 15.)

Trees which have grown in dense, even-aged stands have boles which approach the cylindrical form. Open-grown trees commonly develop strengthening tissues in the roots and the lower part of the stem. However, the uniform resistance to bending is the result not only of distribution but also of density and orientation of the wood substance.

Stem Breakage

During windstorms, the windward side of the trunk is in tension and the leeward side in compression. The compression force is greatest in the outer layers of the sapwood and gradually decreases in intensity toward the center of the stem; the stresses are greatest in the lower part of the trunk. In forest stands when the anchoring strength of the root system is great enough to prevent windthrow during severe storms, the swinging movement of the crown during a storm often bends stems to the point where compression strength of the wood is exceeded.

When the fibers are compressed endwise beyond the elastic limit, compression failures will be produced. At first these failures appear as whitish lines or streaks in the outer growth layers and are mostly indiscernible to the unaided eye. This stage is illustrated in Figure 1. Initial failures of red pine wood (*Pinus resinosa* Ait.) can be seen on a split surface as definite white lines, extending in an inclined direction across the fibers. Microscopic examination of this initial stage showed that some buckling and bending of the fibers had taken place. These minute failures can be found easily in tall, slender conifers which have been bent during windstorms. As trees are exposed to greater stresses during the same or later windstorms, there will be a progressive increase in the number and extent of the failures. Initial failures will extend

FIG. 2.—Tangential offset of gross compression failures in a standing red pine tree. Note the buckled cells along with the lateral displacement of the fibers. Gross failures merge with initial failures toward the center (left side of photograph) of tree. (Photographed under oblique light X 15.)

farther into the bole, while the extent of failure is increased in the outer rings. These gross failures, which can be recognized only after the bark is removed, appear as localized wrinkles or creases in the wood. Such failure is due to the buckling of the cell walls, and its extent depends upon the amount of bending, its location in the stem and the species. The stage where fibers become displaced by a certain distance, but remain parallel to one another, is illustrated in Figure 2. The inclination of the line of failure is predetermined by the direction in which the offset takes place. In the left part of the photomicrograph the gross failures merge with the initial failures.

In addition to compression, diagonal shearing stresses are developed during bending of wood (*16*). Maximum shearing stress occurs along a plane oriented at an angle of 45 degrees with the longitudinal axis, if frictional forces are omitted. In red pine these lines of rupture form an angle of roughly 45 degrees with the longitudinal axis of the tracheids on a flat-sawn surface. A wedge is formed at the point where two of these lines meet. In some instances longitudinal splitting starts at the points of these wedges. This type of failure in a living tree is shown in Figure 2.

Although the bole of a tree is assumed to represent a cantilever beam of constant strength, compression failures are most likely to occur close to the ground. This would indicate that the boles of some trees at least do not represent beams of constant strength. Observations indicated that compression failure was almost invariably distributed at intervals throughout the lowest few feet of the bole. The fact that most of the stands had been thinned recently might account for the concentration of failures at low levels. They mark the beginning of stem breakage in a long-continued storm because during the back-oscillations of the tree compression failures may develop in the outermost rings on the windward side. These fibers rupture, as the swinging and rotating continue, since they no longer possess any appreciable strength in tension. Close examination of more than 100 conifers which broke off during the storm of November, 1950 in the Eli Whitney Forest invariably revealed compression failures both above and below the point of breakage. Figure 3 illustrates the extent and distribution of failures in a red pine broken during that storm. This particular section was cut 3.5 feet above the ground.

Failure in compression also can occur in living stems without complete breakage, provided that the stress imposed is great enough to cause the leeward side to fail in compression but not sufficient to cause failure in tension on the windward side (*7*). A zone of ridges externally visible on the injured side of the stem usually indicates these compression failures. Figure 4 is a photomicrograph of a radial section through the wound tissue of a swelling in a red pine stem, which was formed after compression failure. The section was stained with Bismarck Brown to bring out the contrast. On the right is the wood which was formed during 1950, along with the failure caused by the 1950 storm. A small band of callus tissue covers

FIG. 3.—Extent and distribution of compression failures above and below the line of breakage in a red pine stem. The final failure in tension occurred on the back side of the stem, after compression failures had developed there.

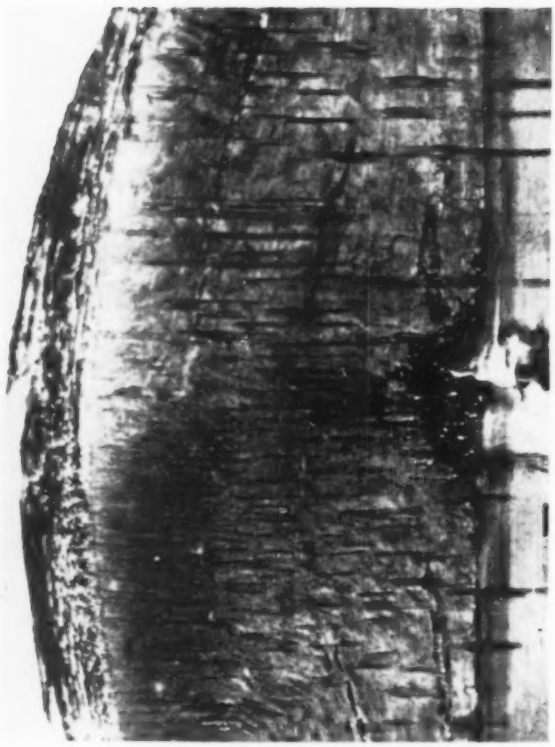

FIG. 4.—Reaction wood formed in red pine after a compression failure. The orientation of the vertical resin ducts is an indication of the fiber displacement. Note the increase in number of resin ducts. (X 13)

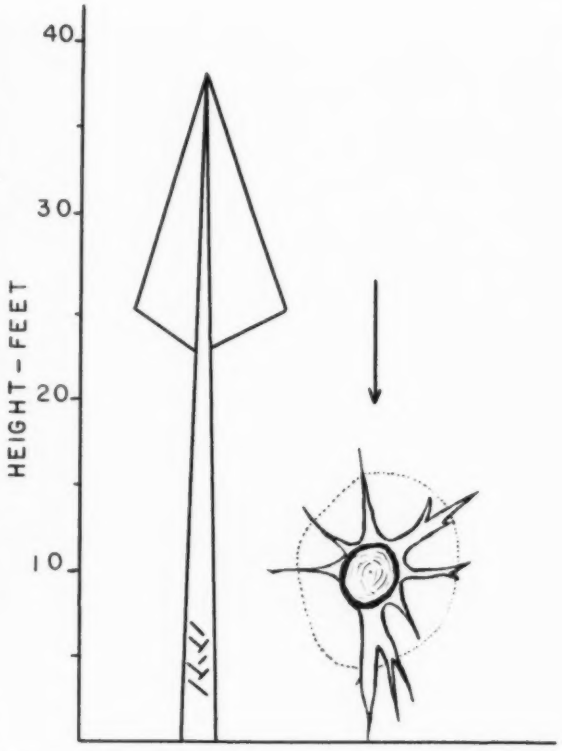

FIG. 5.—Diagrammatic representation of compression failures in a red pine tree. The damaging wind was blowing (at right angles to the plane) toward the observer. The arrow indicates the wind direction with respect to the root system. The dotted line is the projection of the crown.

the wound. The orientation of the fibers in the swelling is not normal. They are inclined from the vertical, and many traumatic resin ducts are formed.

In Figure 5 the compression failures in a red pine tree are diagramatically represented along with its root system. This particular tree which was 39 years old and grew on sandy loam soil in a plantation, had a d.b.h. of 6.3 inches and a height of 38 feet. The 1950 storm inclined the tree about 10 degrees from the vertical. A year later when the tree was cut an examination revealed pronounced compression failures in the zone between 2 feet and 7 feet from the ground. There were no apparent injuries in the principal roots, with the exception that there was some evidence of twisting in one root. None of four bent leaning trees examined which had compression failures in the bole showed any evidence of root failure. They either had a well developed symmetrical root system or the wind was blowing in a direction such that the strongest roots lay on the leeward side.

This study indicated that injured trees are undesirable stand components since they are prone to further wind damage. A Norway spruce (*Picea abies* [L] Karst) illustrated in Figure 6 was injured during three wind storms without complete stem breakage. These storms were the hurricanes of 1938 and 1944 and the November storm of 1959. The southeasterly winds of each storm induced compression failures on the northwestern side of the tree and pronounced swellings of compression wood developed as diagonal ridges over the failures. The tree remained standing until the winter of 1951-52, when lighter, northwesterly winds blowing toward its weakened side caused complete breakage, which was characterized by a brash tension failure in the plane of an old compression failure. Irregular growth after every storm was shown in the annual rings of a horizontal bracket-angle root, which grew on the northwest side of the tree. At the time of breakage the tree was 41 years old and had a d.b.h. of 13 inches.

Root Development and Windfirmness

The roots which strengthen trees against windstorms are not the long slender feeding roots but the stout, short, horizontal or oblique roots of the bracket-angle type. Roots of this type become especially well developed on the leeward sides of trees in exposed situations. In his remarkably detailed study, Fritzsche (*3*) emphasized the importance of root development on the windfirmness of trees. He compared root-systems of fallen and windfirm Norway spruce and pine trees in a blowdown area and found that windfirm trees had stiff bracket-roots on the lee side. In windfirm trees a network of inter-

lacing feeder roots, mixed with soil, was held together by the thick supporting roots. To uproot such trees it was necessary to overturn this "root-ball." In uprooted trees, the break on the leeward side was nearly always near the trunk, while on the windward side the whole "root-ball" was usually uprooted. Fritzsche concluded from his observations that the anchoring ability of a tree is determined by the stiffness and cross-breaking strength of the roots on the leeward side and not by the tensile strength on the windward side, or the shear value of their attachment with the soil. Pryor (*10*) studied the development of roots of *Pinus radiata* in relation to wind resistance. In places where windthrow was sporadic, he found that the fallen trees often lacked a firm horizontal root in the direction of fall, whereas adjacent windfirm trees of the same crown class invariably had a strongly developed root in the equivalent position.

As mentioned earlier in this paper, green wood is much stronger in resistance to tension than in resistance to compression. The roots on the leeward side are subjected to compression in their upper halves while the roots on the windward side are subjected to tension. Roots on the windward side running at a right angle with the stem are subjected to tension forces only after the stem has been tilted upward from its normal position. When the bracket-angle roots are horizontal this cannot happen until after the roots on the leeward side have failed in compression. The same is true in most instances where the inclination of the bracket-angle roots does not depart substantially from the horizontal. The rope-like feeders are of little mechanical significance since they snap quickly, once the balance of the tree is upset sufficiently. Similarly the tap root of most species is only of minor mechanical value. According to Fritzsch'e calculations (*3*) the tap root of a 100-foot tree would have to extend about 10 feet below the ground level to make the particular tree stable, and the diameter of the tap root would have to be the same all along its length and be equal to the d.b.h. of the trunk. However, on certain soil types the tap root may add considerably to the windfirmness of individual trees.

The influence of a soil on the ability of a tree to resist blowdown is twofold. Soil texture effects the distribution of the roots, and soil consistency influences the anchoring ability of the roots. The pattern of root growth is greatly influenced by soil aeration, ease of root penetration and moisture-holding capacity. Although different species react differently, in general one can say that loose sandy soils lead to the formation of deep, spreading root systems having few branches, whereas in dry clay soils, the root systems are shallower and less wide spreading. Jacobs (*4*) concluded after reviewing Fritzsche's article on storm adaptation by trees, that "given sufficient stimulus to the bracket-roots (whether horizontal or oblique) the tree can develop an efficient anchoring mechanism on shallow soils."

The resistance of a soil to pressure, thrust and pull varies with texture, organic matter, colloidal material and especially the moisture content. The most important physical forces determining the consistency of a particular soil are

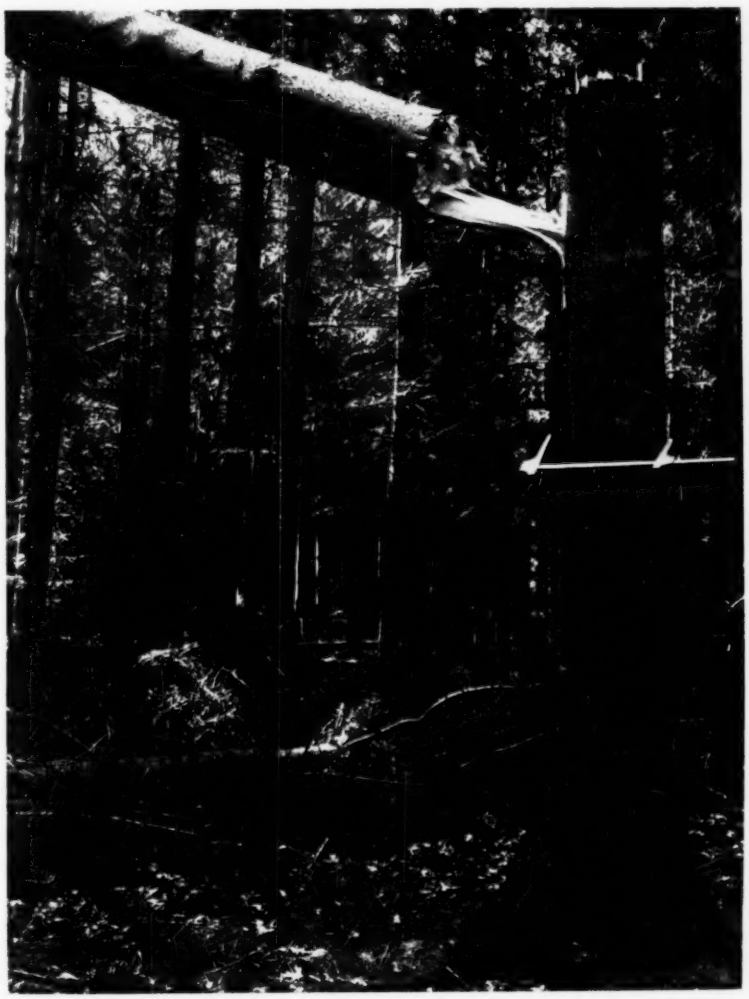

FIG. 6.—Wind breakage along the plane of an old compression failure in a Norway spruce tree. Ridges covering up old compression failures are noticeable below and above the line of brash tension failure.

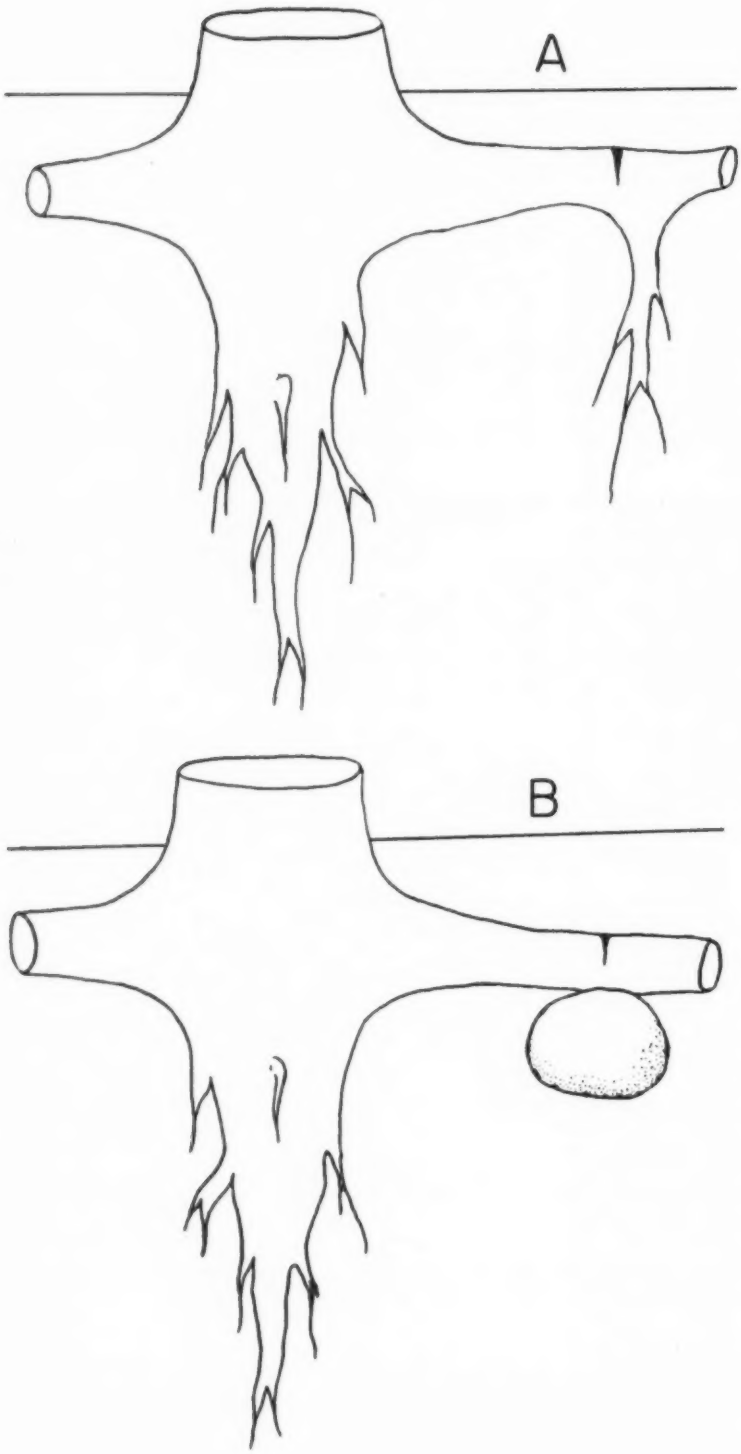

FIG. 7.—Compression failures on a leeward side in the bracket-angle roots of red pine. The downward movement was prevented in *A* by a sinker root and in *B* by a large stone.

its cohesive and adhesive strength and the angle of internal friction. Non-cohesive materials, such as dry sands, anchor trees through frictional forces only and these sandy soils are most resistant when their moisture content is at or close to field capacity. Clay soils in contrast to sandy soils, exhibit their greatest cohesion when dry.

A large number of uprooted conifers and hardwood trees were examined during this study. All bracket-angle roots present on the leeward side had failed in compression. In some cases none had formed. The failures most commonly occurred at a place where the root was unable to move downward during the oscillation of the tree. Downward movement was prevented either by sinker roots or by large stones as shown in Figure 7. Leaning, partially uprooted trees were held only by the roots on the windward side. The root systems of eight partially uprooted, leaning trees were completely excavated after the trees had been cut down. In every case where roots were present on the leeward side, they had failed in compression, whereas only the feeder roots on the windward side had snapped.

Discussion

The high incidence of ordinary wind damage in partially cut stands and in thinned plantations is of great concern to the practicing silviculturist. Smith (*13*) has distinguished between two general approaches to the protection of stands against storm damage. He discussed how individual trees can be made windfirm and how the resistance of stands to windfall can be increased by controlling their structure, through proper alignment of cutting areas and development of firm stand borders.

The fact that bending of the stem causes stimulation of the cambial layer in tree stems and roots can be utilized to protect the trees against wind damage. It has been shown that the increased exposure of trees to bending stresses has increased the growth of stems and roots in such a manner that

windfirmness is increased. If trees are to be made windfirm, they should be exposed to the wind while they are still young, before the main part of height growth has been made. Young stands should be subjected to repeated crown thinnings to expose them to a liberal amount of wind. The trees will develop strengthening tissues in the lower part of the stem as well as a strong supporting root system. Of the conventional silvicultural systems, the selection method will probably produce stands of the greatest wind resistance. However, neither frequent thinnings nor the light cuts of the selection system are advisable in dense stands which have gone unthinned for years. Also, these cuts are not considered economically feasible in many forest types of North America. In these cases attempts to form wind resistant stands will be generally limited to the preservation or establishment of solid stand borders, using the most wind-resistant species available and the arrangement of fellings in the proper sequence. While normal storm damage can be minimized by good silviculture, there is no way of completely preventing loss caused by gusts of hurricane force.

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Artificially Induced Senescence of Forest Trees[1]

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IT IS FREQUENTLY difficult to determine whether certain insects or fungi that invade dying trees are contributing to the senescence or death of the trees, or whether the insects and fungi are present because the senescent or dying trees provide an environment favorable for their development. The aims of the study here reported were: (1) to test various methods of inducing, artificially, senescence in forest trees, and (2) to record the invasion of such trees, as they weakened and died, by various insects and fungi. By these means we hoped to gain some information on the probable relationship of certain insects and fungi to the decline and death of trees. We recognize that information gained in this way must be largely circumstantial, but this approach was felt to be justified, first, by the recognized difficulty of getting direct evidence regarding the invasion of trees in their natural habitat by certain insects and fungi; and, second, by the light that information so gained might shed on evidence obtained either by observation or by actual experimental work in the forests.

Attempts to Induce Artificial Senescence by Wounding

In 1939, five to ten trees of each of seven species were wounded as follows:

1. A strip of bark and outer sapwood about one inch wide was removed for nearly the full circumference of the tree, about four to five feet above the ground, leaving only a portion of sound bark about one inch wide.

2. All of the roots extending out from one-half of the root crown were severed, a few inches away from the trunk.

3. Several of the larger roots were wounded by removing the bark from the upper side of the root for a distance of several inches, or were cut partially through with an axe a short distance from the trunk.

The kinds of trees so wounded, and their approximate ages, were: tamarack, *Larix laricina* (du Roi) Koch, 60 years; balsam fir, *Abies balsamea* (Linn.) Mill., 60-70 years; white spruce, *Picea glauca* (Moench) Voss, 35 years; jack pine, *Pinus banksiana* Lamb., 15 years; quaking aspen, *Populus tremuloides* Michx., 30-35 years; and paper birch, *Betula papyrifera* Marsh., 30-35 years. All of these were located in or near Itasca Park, in northwestern Minnesota. All were in natural stands except the jack pine, which was in a plantation.

These trees were examined at intervals of six months to a year for five to seven years. This examination involved cutting into the inner bark on the trunk and roots above and below the wounds at each examination period.

Results of Treatment

None of the treatments resulted in general decline in vigor of any of these species, with the possible exception of balsam fir. Two of the ten trees of balsam fir that had been partially girdled died within the ensuing seven years. For several years preceding death, cankers apparently caused by or contributed to by *Cephalosporium album* Preuss. developed both above and below the girdled portion. Several small cankers in which the same fungus appeared to be involved developed adjacent to the partial girdles on several other balsam fir trees, but after a few years the cankers ceased to enlarge. Christensen (*1*) inoculated a number of small, suppressed balsam fir trees in the same general region with *C. album* some years ago. The fungus invaded and killed the inner bark of these inoculated trees, and appeared to behave as a rather vigorous and primary parasite. The present evidence suggests that *C. album* is only a secondary invader, or at most a weak primary parasite of balsam fir, since several of the cankers that began to develop eventually died and caused no injury to the trees. The results obtained by actual inoculation of trees, as reported by Christensen, may have been influenced partly by the fact that the trees he inoculated were already severely weakened by suppression, partly by the artificiality of introducing a heavy load of inoculum. Such qualifications are inherent in most experimental work, although they often are not recognized.

Both of the balsam fir trees that died became very heavily infested with *Pityokteines sparsus* (Lec.), a small bark beetle known to thrive in dying and recently cut balsam fir. Dodge (*7*) states that this insect is considered to be a primary enemy of balsam fir. As here encountered, this bark beetle followed or accompanied, rather than caused, the death of the trees. Additional evidence on the secondary role of this insect will be given later in the paper.

Wounding or severing the roots of various species of trees did not induce senescence of the trees. The trees whose roots were wounded or severed as described above continued to grow and thrive. Growth in height and diameter appeared to be quite normal even when the tree was supported by only a single root. A few of the jack pine trees, most of whose roots were severed, were windthrown because of lack of sufficient roots to support them, but even these windthrown trees continued to grow rather vigorously for some time, even though supported by only a single root. So far as could be determined by dissection and examination of the roots five to seven years after wounding or severing, there was almost no invasion of the roots toward the trunk by wood-rotting fungi. Mechanical wounding of

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roots has been assumed to afford entrance by fungi that would invade the roots or the butt of the tree. There has been little or no experimental evidence to support this contention. The evidence here obtained, admittedly not extensive, does not indicate that such wounds provide a ready entrance for fungi that might invade the heartwood of the tree. Also, wounding or severing roots obviously did not induce senescence in the trees here studied.

Artificial Senescence Induced by Banding

In 1941, 15 trees of each of the above species, plus red pine, *Pinus resinosa* Ait.; white pine, *P. strobus* Linn.; black spruce, *Picea mariana* (Mill.) Brot., Sterns, and Pog.; and red oak, *Quercus borealis* Michx. on the University Forest Experiment Station near Cloquet, Minnesota, and ten 12-year-old jack pine in a plantation at Itasca Park were girdled with metal bands. All of the trees at Cloquet were 25 to 35 years old and, except for the tamarack and jack pine, were vigorous, fast growing, and on moderately good sites. A band of galvanized iron about one inch wide was fastened tightly around the trunk of each tree about five feet above the ground. The ends of the band were overlapped and nailed to the trunk. As the trunks increased in diameter, the bands constricted them, resulting in eventual death of most of the trees. Observations of insects and fungi that invaded these trees as they died are summarized below.

Results of Treatment

White Pine

Of the 15 trees banded in 1941, 11 had died by the fall of 1947. While some variation occurred from tree to tree, the general course of decline was surprisingly uniform. The first symptom of impending death was the appearance of small brown patches in the bark below the constricting metal band. In three to six months after these brown patches first appeared, they enlarged and gradually coalesced to form rather sharply defined longitudinal brown streaks of dead inner bark. These zones of dead inner bark progressed downward from the band and upward from the roots. They gradually increased in width until all the inner bark below the band was dead and brown.[3] In most cases the tops of the trees looked completely normal until all of the inner bark below the band, and that of the roots near the base of the tree, had been dead for several months or longer. Usually the terminal growth of twigs during the season in which death occurred was shorter, and the foliage slightly thinner, than that of normal, unbanded trees in the stand, but if the trees were not examined critically and in detail those on the verge of death appeared to be quite normal. As compared with adjacent nonbanded trees of the same age in the same stand, the diameter growth of the banded white pine was somewhat greater than normal just above the band, about equal to other trees in the stand from a foot or more above the band upwards, and much less than normal below the band.

Armillaria mellea (Vahl.) Quel. invaded the inner bark and cambium region of the roots very soon after these tissues became brown, and long before the tree crowns disclosed any evidence of impending death. If the bark below the band was not invaded by beetles, *A. mellea* progressed a foot or two up the trunk in the cambium and inner bark. The gross symptoms of infection of these trees by *A. mellea* were identical with those on forest trees which this fungus supposedly has invaded and killed. *A. mellea* has been considered to be a primary parasite of forest trees in their natural habitat. In the present tests, this fungus invaded the roots and lower trunk of nearly all of the dying trees, but only after that portion of the trunk below the constricting band already was dead. The fungus obviously was present in the soil throughout the stand, since the dying or dead portions of all of these trees that succumbed to the constricting bands were invaded by it. In all of these cases *A. mellea* was a secondary invader.

Very few insects attacked the dying white pine trees. The first signs of insect invasion were the egg galleries of *Hylurgops pinifex* (Fitch) in patches of dead bark near the root crown. As the dead areas enlarged, *H. pinifex* and the weevil, *Pissodes approximatus* Hopk. became established between the band and the root crown. *Hylurgops* prefers the base of trees as its habitat. According to Craighead (*6*) it is a secondary invader of pines, spruce and larch for which no control is necessary. The usual breeding places of *P. approximatus* are freshly cut logs, stumps, and blowdowns, but occasionally they attack young trees that have been weakened. One unidentified Buprestid larva also was found in dead bark below the band of a white pine tree that had been dead for several months. No insects were found above the bands until several feet of bark above the band had turned brown, and even then they were not abundant. The small bark beetle, *Pityogenes hopkinsi* Swaine, was the only species collected from bark above the bands. This is a very common species in dead and dying white pine.

Red Pine

Slight constrictions began to develop at the bands in 1942 and by 1944 the diameter of the trunk both above and below the band was ¼ to ½ inch greater than the diameter of the banded portion. The terminal growth of the twigs and density, color and length of leaves appeared normal on all of the banded trees. The only sign of senescence was slight discoloration of the inner bark below the band of one tree. No insects or fungi were found invading the roots or trunks of the trees at this time.

By the fall of 1947, 11 of the 16 banded trees were dead. As with white pine, the course of decline of the different trees was very similar. The bark below the band died first, either beginning at the roots and working upward, or occurring simultaneously throughout the region between the band

[3] These results are essentially in agreement with the conclusion drawn by R. M. Belyea, 1952, Jour. Forestry 50: 729-738.

and the root crown. During the season in which the cambium below the band turned brown, there was little or no terminal growth of the twigs; thus, in red pine, death of the roots and lower trunk was followed more quickly by symptoms in the crown than was the case in white pine.

Heavy wefts of mycelium of *Armillaria mellea* grew in the inner bark of the roots and lower trunk of all of the dying or dead trees, sometimes completely covering these tissues from below the soil surface to a foot or two up the stem, but the fungus did not appear until several months to a year after the inner bark and cambium had died.

The weevil, *Pissodes approximatus* Hopk., invaded the inner bark of the trunk below and immediately above the band after the bark tissues had become brown. The pine sawyer, *Monochamus scutellatus*, (Say) and *Ips pini* (Say) invaded the trunk above the band and below the upper branches after the trees were obviously dying or dead. They never invaded the trunks below the band. The bark beetles *Pityophthorus puberulus* Lec. and *Pityogenes plagiatus* Lec. invaded the bark of branches and the upper portion of the stem after the trees were dead. Both are known to be secondary invaders of material of small diameter.

Black Spruce

Although most of the banded trees were dead by the fall of 1947, no adequate picture of the course of deterioration was obtained. Most of them died very suddenly, symptoms of death appearing simultaneously throughout the tree. Thick wefts of mycelium of *Armillaria mellea* were found growing up from the dead roots of one tree. The bark of most of these trees either dried out so rapidly, or was so heavily invaded by bark beetles, *Dryocoetes piceae* Hopk., that even if *A. mellea* had been present on the roots it scarcely could have grown up in the inner bark of the trunk. The bark beetle *D. piceae* is known to develop in dying or recently cut trunks of spruce.

Balsam Fir

These trees grew very slowly, and by 1948 only 4 of them had died. *Armillaria mellea* was found in abundance in the inner bark and cambium of the roots and lower stem of all four of these. Of these four, three were heavily infested with *Pityokteines sparsus*, and there was some invasion by an undetermined species of *Monochamus*. Both the fungus and the two species of insects appeared definitely to be secondary.

Tamarack

The trees grew so slowly that after 8 years only slight constrictions had appeared at the bands. One tree died in 1948; it was invaded by a bark beetle, *Scolytus piceae* (Sw.), common in dying trees. No obvious fungi were present.

Jack Pine

The trees banded at Cloquet grew slowly and constriction first became obvious in 1948, seven years after bands had been fastened on the trees. The inner bark of the lower stem and of the roots appeared to be normal on the several examined. No insects or fungi had invaded the trees, and the only obvious symptom of distress was a heavy production of staminate flowers by some of the trees on which the constrictions were the most advanced. The younger trees banded at Itasca State Park responded to the injury more quickly. Three years after they were banded most of the trees were either dead or dying because the rapid growth brought about deep constriction at the bands very quickly. In those trees still holding their discolored needles the small bark beetle, *Pityogenes plagiatus* (Lec.), was very abundant above the bands in areas where the phloem had become brown. Their galleries stopped abruptly at the margin of green phloem near the top of the crown. The trees which had died in the fall or during the winter showed more advanced stages of deterioration and were infested with *Pissodes*, *Monochamus* and the ambrosia beetle, *Gnathotrichus materiarius* (Fitch). Blue stain, caused by *Ceratostomella* sp., was common above the bands on most of these trees but *Armillaria*, if present on the roots, had not advanced to appear at the root crown and lower trunk region.

Hardwoods

Few of the banded hardwood trees have died to date. Several aspen obviously on the verge of death were cut and examined. The leaves of these were small and sparse as compared with leaves of the normal unbanded aspen adjacent to them. Irregular areas of brown, dead inner bark, irregular in outline and up to two feet in length, were visible when the outer bark was cut away. Heavy mats of fresh mycelium of *Armillaria mellea* were found around the root crown, but did not completely occupy all of the dead bark at the base of the trunk. In those areas of the bark that had died a few weeks previous to the time of examination, *Cytospora chrysosperma* (Pers.) Fr. and *C. nivea* (Hoff.) Fr. were fruiting heavily, but where the inner bark was just turning brown and the outer bark was not sunken or discolored, *Cytospora* had not yet begun to fruit. The fungus was probably generally present in the outer bark, and fruited only after the bark died. *Agrilus liragus* Barter and Brown and *Trypodendron retusum* (Lec.) had begun to invade the recently dead bark below the band in the few dying trees that were cut, but no evidence of their presence was found in the bark of those banded trees which were not dying, nor were they present above the bands.

One birch which died in 1948 was attacked by the bronze birch borer, *Agrilus anxius* Gory. As in the case of *A. liragus* mentioned above the tunnels were found only under the dying bark below the band. These results agree with those of Anderson (*1*).

Discussion

The studies here reported involved only relatively small numbers of trees, in a rather limited environment. Even with these qualifications, information of some

value has been obtained. Perhaps one of the more obvious conclusions is that no one can tell, by ordinary examination of the exterior of a tree, whether the tree is declining, dying, or even dead, at least until some time after it has died. There is at present no adequate measure of health or vigor in a forest tree. Students of fungi and insects which may invade forest trees may well be wary of deciding whether a given invader of trees is a primary invader or just invading trees that already are dying.

Armillaria mellea appears to be a more or less normal and general inhabitant of the soil in the areas where these studies were made. It invaded nearly all dying trees of all of the species that were killed by banding. There was no evidence that it was injuring or killing unbanded trees in the same stands. This does not exclude the possibility that races or varieties of this fungus exist that are capable of invading and killing healthy forest trees. Thomas (*9*) showed that the fungus would invade presumably sound roots of orchard trees. Benton and Ehrlich (*3*) described a number of distinct cultural types of the fungus isolated from western white pine. However, the results of this study do definitely indicate that the mere finding of mycelium of this fungus in the inner bark of the roots or lower trunk of forest trees that are dying is by no means good evidence that the fungus is invading and killing healthy trees, as often has been assumed in the past. Also, if forest soil in general is as commonly inhabited by *A. mellea* as was found here, even tests in which trees are inoculated with the fungus might not yield reliable results unless one could distinguish with certainty between the inoculum artificially applied and the inoculum naturally present. Even should artificial inoculation of trees with certain strains of *A. mellea* prove them to be parasitic, from a practical forest management standpoint in the area studied, it would seem that the fungus can be more or less dismissed from consideration as a damaging factor.

The fact that species of *Cytospora* fruited abundantly in the dead bark of aspen, but did not appear in those areas of the trunk where the inner bark still was green, supports the contention that this fungus is a normal inhabitant of the bark of Populus (and probably of other species of trees) and fruits in abundance only after the bark has died. There is at present no good experimental evidence that *Cytospora*, so commonly associated with dying bark of poplars, willows and other species of trees, actually invades and kills the bark. The evidence here obtained supports the contention made by Christensen (*5*) that *Cytospora* is merely a secondary invader of bark killed by other causes.

Although the evidence obtained in these studies is neither extensive nor conclusive, the fact that when roots of trees were wounded or severed, no obvious invasion by wood rotting fungi or that portion of the root still attached to the tree was observed within a period of seven years after such injury, casts at least mild doubt on the belief that mechanical wounding of the roots exposes or predisposes forest trees to invasion by wood rotting fungi. There is no conclusive proof that root or butt rotting fungi of the tree species here studied, enter primarily or even occasionally through wounded roots.

All of the insects found in the dying trees here described have been considered by most authorities to be secondary invaders of dead or dying trees. With a few exceptions, the nuptial chambers of bark beetles or the egg niches of pine sawyers were found only when the phloem had begun to discolor or had already turned brown. Most insect attack of the banded trees occurred above the bands, where the bark and cambium apparently died more slowly than below the bands, although a few species of insects that commonly are found in recently cut stumps were found in the dying phloem below the bands. As concluded by Anderson (*1, 2*) and Hawboldt (*8*), trees must be severely injured, senescent, or approaching death before insects such as the bronze birch borer and certain bark beetles can attack them successfully.

These studies were preliminary and exploratory in nature. They by no means solved many of the problems involved in the question of primary-vs.-secondary invasion of trees by fungi and insects. They served to explore several possible methods of inducing artificial senescence, and to provide one method that may offer a point of departure for future studies of this kind. They also emphasize the fact that, with certain fungi and insects that invade forest trees, a state of mind involving a wholesome amount of doubt may be desirable even when dealing with rather conclusive observational or experimental evidence.

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Notes

Applying Unit Area Control to Watershed Management

Unit area control, "the detailed control of stocking of small areas," was developed by Dunning and reported by Hallin[1] as an approach to the task of converting old-growth forests to managed timber stands. It would seem that watershed managers should give serious thought to the possibility of applying the principle of unit area control to the integration of timber and water production in forests now being converted from an unmanaged to a managed condition.

The silvicultural concept of unit area control involves two key principles. The "unit area" principle refers to the division of treatment areas by natural units or homogeneous stand units. These may vary in size from a fraction of an acre to many acres. Hallin lists age class, species composition, stocking, and presence or absence of seed trees as stand characteristics commonly used to determine the homogeneity of unit areas or stand units. "Control" refers to the silvicultural treatment applied by the forester to the unit area with the intent of controlling the stand to meet the owner-objectives.

To plan for watershed management, the characteristics determining homogeneity of stand units (i.e. age class, species composition, stocking, and presence or absence of seed trees) must necessarily be broadened to take into account such hydrologic unit areas as can be delineated in terms of topography and soils characteristics. These might include parent material, soil depth, slope, aspect, and soil type.

In a similar manner, the treatment in terms of water values must be incorporated into the "control" as well as into the "unit area." Thus, principles of protection forests and special water resource management practices must be considered in the proposed treatments along with intermediate and harvest cuttings designed primarily for timber production.

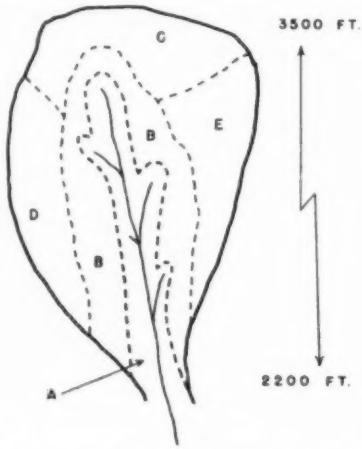

FIG. 1.—Hypothetical example of unit area control concept to watershed management.

A hypothetical example of application of the unit area control concept to watershed management is shown in Figure 1. Areas A and B would probably constitute a single treatment area for timber management, but are differentiated for water resource management. Area C constitutes a unit area for both timber and water resource management, with the control designed primarily for water resource management. Areas D and E were delineated as unit areas with both objectives in mind, but the cultural measures proposed are predominantly timber management operations.

Area A

Riparian cove hardwoods.

Possible treatment.—Poison all pole-sized stems and larger for increased water yields.

Area B

Immature cove hardwoods on deep talus deposit.

Possible treatment.—Thinning to increase water yield by reduction in basal area and to improve quality and species composition of stand.

Area C

Scattered residual mature oak-hickory type with adequate second-growth reproduction on a very steep slope, shallow soil, and southern exposure.

Possible treatment.—Cutting of mature wolf trees to reduce landslide possibilities.

Area D

All-aged oak-hickory type, gentle slopes, adequate soil depth.

Possible treatment. — Improvement and harvest cut, selection system.

Area E

Immature shortleaf pine, southerly exposure, intermediate soil depth.

Possible treatment. — Pulpwood thinning for timber products.

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[1]Hallin, W. E. Unit area control in California forests. California Forest and Range Experiment Station, Forest Research Note No. 77, 8 pp. March 15, 1951.

Temporary Tree Marking

Research and extension foresters frequently have occasion to designate trees by a temporary mark. A common method involves the use of lime in a cotton sock. A tree is marked by a light blow with the lime-sock. The chief drawback is that the lime dust irritates the eyes. Prolonged use affects the skin of the hands—extreme dryness, irritation, and cracking of the skin is often the case.

There are a number of good substitutes for lime which do not have its bad features. One of these is kaolin, derived from a pure white clay of the same name and used for various commercial purposes. However, kaolin is not easily obtained in most localities. Recently we have found that marble dust, a by-product of monument manufacturing, is an excellent substitute for either of the foregoing. Most

towns of medium size or larger can boast of at least one monument maker. Consequently, the marble dust should be obtainable in many localities. In our area it is also packaged and sold for line-marking football fields and tennis courts. This indicates that sporting goods stores may also stock this material. Fifty pounds can be purchased for about $1.50.

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Isolations of Fungi in the Field Using the Swedish Increment Hammer

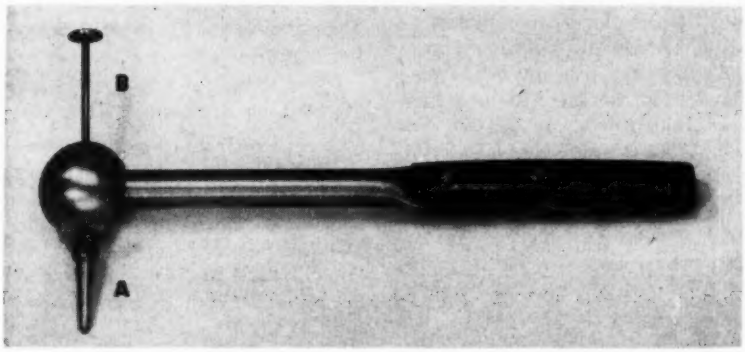

FIG. 1.—Swedish increment hammer with hollow core-cutting unit at A, and plunger to remove core at B.

A rapid field method for making isolations of fungi from lower trunks and from roots of forest trees saves the labor of chopping out sections of infected wood and bark, carrying them to camp or laboratory to make the isolations.

Bark lesions sapwood infections and root fungi such as *Armillaria mellea* and *Leptographium* spp. may be sampled quickly and isolations made at the tree.

The Swedish bark instrument or increment hammer,[1] designed to cut a one-eighth-inch core through the bark, is used to obtain a core containing infected tissues (Fig. 1). The suspected area of bark on root spur, root collar or lower trunk is first smoothed and the bark depth reduced by means of a belt axe. The bark surface and the cutting head of the bark instrument are swabbed with 95 per cent alcohol to sterilize them. When the alcohol has evaporated from bark and tool, the cutting point of the hammer is driven deep through the bark and into the sapwood, loosened by turning, and removed from the tree. The core is then pressed out of the cutting head into a culture tube by means of the plunger on the hammer. Slant agar tubes are used and the cores are agitated within each tube until each is lying flat in contact with the agar surface. Mycelial mats of *Armillaria mellea* and parts of other root fungi in and beneath the bark and outer sapwood produce mycelia which become established on the agar media free of outside contamination.

The method can be used on any part of freshly felled stems and large branches, on the lower end of standing trees, or on the root spurs and root colars of stumps suspected of supporting *Armillaria mellea* or other root fungi.

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[1]Made in Mora, Sweden, and distributed by Sandvik Saw and Tool Corp., New York 7, N. Y.

Excellent Reading in German Forestry Periodicals

Browsing through the Yale School of Forestry library recently, I found several articles of unusual interest in German language forestry periodicals of recent issue. These are not generally read by American foresters (even students!) so I thought a brief mention of three or four of the salient articles might interest S.A.F. members.

No. 1 is in the *Allgemeine Forst — und Jagd — Zeitung* (Vol. 125, No. 1) entitled: "Unterlagen fuer den Anbau Westamerikanischer Nadelholzarten in Deutschland" ("Bases for planting Western Conifers in Germany") by F. K. Hartmann, F. Querengaesser, and G. Jahn. It contains an excellent tabular summary of the principal western species according to silvicultural characteristics and possible use in Germany.

No. 2 is in the *Zentralblatt fuer die Gesamte Forst—und Holzwirtschaft* (Vol. 72, No. 1) entitled: "Holztransport mit Langstrecken —Seilkranen" ("Logging with Cableway Skidders") by Dr. E. Pestal. It contains more information about the Wyssen system as used in mountainous areas in Europe and Canada; also other systems used in Europe. Excellent photos accompany the article.

No. 3 is in the *Allgemeine Forstzeitung* (Vol. 64, Nos. 19-20) entitled: "Das Baumzaehlrohr" ("The tree-counting tube") by Dr. G. Mueller. It deals with a new mensuration instrument for counting trees (on sample plots), telling also heights and diameters.

No. 4 is in the *Forstarchiv* (Vol. 24, No. 8) by Dr. Mayer-Weggelin and describes a small area of virgin forest in the mountainous province of Steiermark (Styria) in Austria.

These are just samples; the German periodicals are a rich mine of information for American foresters. They deserve a wider reading in this country.

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Re-establishment of Shortleaf-Loblolly Pine Under Four Cutting Methods

Immediate and adequate pine reproduction in openings created by the removal of mature trees is the aim of all foresters managing shortleaf-loblolly pine-hardwood stands. The question is: How do the various cutting methods now in general use in this timber type compare from the standpoint of securing adequate pine restocking? In 1937 the Southern Forest Experiment Station set out to study the problem at the Crossett Experimental Forest in southern Arkansas.

Cutting Methods Used

Four cutting methods were used:

1. Clear-cutting all pine larger than 6.5 inches in d.b.h. in 4.3-acre openings, with seeding from the side.

2. Cutting all pine larger than 11.5 inches in diameter.

3. Leaving about 15 seed trees larger than 11.5 inches, per acre.

4. Cutting by the single-tree selection system, at 5-year intervals.

Three 4.3-acre plots of each treatment (2.5-acre central plot with 1.8-acre isolation strip) were established in 1937 in previously unmanaged second-growth shortleaf-loblolly pine-hardwood stands. A second series of plots was established in 1942. Except on the selection system and the 11.5-inch diameter limit plots, no cutting was done after the plots had been established.

In 1939 there was a bumper pine seed crop, followed by favorable weather. This combination resulted in very good initial seedling establishment and first-year survival. Another good seed crop was produced in 1942 with similar results.

Since the study plots were heavily stocked with hardwoods of all sizes, permanent establishment of the pine seedlings depended upon release from these trees. A variety of hardwood control methods, including burning, were initially tried, but ultimately all hardwoods larger than 3.5 inches in diameter were cut or girdled on all plots. This treatment effectively released the pine seedlings.

Photo U.S.F.S.

FIG. 1.—Loblolly pine reproduction in 1951 on a plot cut selectively in 1942. To obtain the results pictured here, all hardwoods over 3.5 inches in d.b.h. had to be eliminated; this was done in 1948.

Good Pine Restocking Obtained

A pine restocking inventory was made in December 1951, at 14 and 9 years following the original cutting of the first and second series of plots, respectively. One hundred milacre quadrats were mechanically spaced in each 2½-acre plot—a total of 2,400 milacres.

Lack of pine reproduction, which might be of concern in the open or under hardwoods, is immaterial under larger pines. In the inventory, therefore, any quadrat whose center was overtopped by a pine larger than 3.5 inches in diameter was classified as not needing reproduction. Quadrats not overtopped by larger pines were divided into two groups — those that had restocked with at least one pine seedling, and those that were still bare.

The results of this inventory are summarized in Table 1. As would be expected, the percentage of milacres overtopped by large pine (and hence not in need of pine seedlings) was least on the clear-cut plots and greatest on those selectively cut (column 2).

Under all methods of cutting, most of the milacres not overtopped by larger pines have filled up with seedlings, so that 84 to 94 percent of the total area on all plots is now occupied by pine (column 3). The seed-tree plots are only slightly better stocked than the others, and the clear-cut plots are only a little less so.

The total number of pines under 3.5 inches d.b.h. is ample on all

TABLE 1.—PINE STOCKING, 1951, UNDER FOUR CUTTING TREATMENTS ESTABLISHED IN 1937 AND 1942

Cutting treatment (1)	Milacres overtopped by pines larger than 3.5 inches d.b.h. (2)	Total milacres stocked with pine of any size (3)	Pines per acre smaller than 3.5 inches in d.b.h. (4)
	Percent	*Percent*	*Number*
Clear-cut	15.3	83.7	2,470
Diameter-limit	27.0	87.3	3,205
Seed-tree	27.0	93.6	3,845
Selection	50.5	85.8	2,903

plots (column 4). In general, the reproduction looks healthy and vigorous. On the seed-tree plots, more than a third of it is between 0.5 and 3.5 inches d.b.h. On the clear-cut plots one quarter falls in this class. The plots cut to 11.5 inches and the selection plots have 19 and 7 percent, respectively, of their pine reproduction in this size bracket.

On the clear-cut and the diameter-limit plots, about 82 percent of all milacres without pines larger than 3½ inches d.b.h. have been occupied by pine reproduction. On the seed-tree plots, 92 percent of such milacres have restocked to pine. The selection plots have 73 percent of such milacres restocked (Fig. 1).

So far, it appears that with proper hardwood control and an adequate seed source, good reproduction can be obtained with any of the four cutting methods that were tested.

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Japanese Forestry Notes

The following item was received November 1, 1953, from the author. Its publication is for the information of those American foresters who saw postwar service in Japan, as well as those who will view the observations contained in the light of general interest.

The Forest Agency announced that seedlings are now being produced in excess of the requirements of the reforestation plan and will now place more emphasis on quality rather than quantity.

The Forestry Agency's sawmill survey last fall showed 40,200 mills, of which 25,600 had circular saws, 5,300 carriage bandsaws, and 4,300 hand feed bandsaws. This contrasts with a total of 7,500 mills reported in 1945. It indicated that 8,400 were established since 1950 largely as a result of U. S. Army buying. A third of the mills have units of less than 10 horsepower. Many of these mills are idle because of a lack of logs.

The pulp and paper industry recently petitioned the Forest Agency to discard the bidding system for timber sales and make individual annual concontracts. In addition there were proposals on prices and payments, all of which were firmly and politely rejected.

The Japanese Diet, in response to the opposition of various wildlife organizations, recently beat down an amendment to the Hunting Law which would permit the netting of thrush and other small birds. However a recent Japanese newsreel showed the netting of thousands of these birds in an agricultural district.

A breach has appeared in the Forestry Agency's ban on the export of softwoods, with the Aomori Crosstie Association, obtaining approval after 3 years of "negotiations," to export 100,000 Hiba (False arborvitae) crossties to Formosa.

A June cabinet conference decided that the boundaries of the forest regions on the main island of Honshu should be revamped to conform more closely to watershed boundaries rather than prefectural boundaries as at present. It was also decided that after Diet approval, Maebashi Regional National Forest Office would be abolished; a new one would be established at Fukushima, and the Nagano office would be removed from Kiso-Fukushima a small town in Nagano to Nagano City, a prefectural capital. It is expected that considerable savings in administrative expenses can be made by these steps.

Discussion in the Forestry Agency is being centered on the Temporary Reforestation Law passed in 1950 which allows a third party to reforest the land of an owner who has no intention of doing so and which has been designated in need of reforestation by the prefectural government. A million and a quarter acres have been designated to date with another nearly half million acres to be designated this year. The Reforestation Section wishes to hold to the law while the Forest Administration Section feels that reforestation can be increased through amending the current Forest Law.

Japan exported $12,650,000 worth of forest products in 1952, $4,000,000 less than in 1951. The bulk, $9,340,000, consisted of 65,000 Mbf of lumber, nearly 80 percent of which was one inch Nara (Oak) and Sen (Kalopanax). Of the nearly 59,000,000 square feet of plywood, valued at $7,328,000, that was exported, more than 80 per cent was Philippine Lauan. Flooring, box shooks, and veneer tea and rubber chests comprised the balance of the exported products.

Owing to the frequent discrediting of Japanese forest statistics, the Forestry Agency is commencing a new sampling survey of the Japanese forest area, volume, and growth.

Mr. N. Yokokawa, who earlier this year resigned as Director-General of the Forestry Agency, has been elected to the Upper House of the Japanese Diet. Mr. Miura, also a former Director-General, was re-elected to the same body.

The Economic Counsel Board has reached the conclusion that at the current cutting rate, Japan's forest (including inaccessable) will be exhausted in 30 years. Five years ago the Forestry Division, NRS, GHQ, SCAP, predicted exhaustion of accessible softwood timber stands in two decades.

The 6th annual Arbor Day tree planting ceremony with the Emperor and Empress of Japan in attendance was held in Chiba Prefecture this year. Frank Spinar and Donald Haibach, Japan Procurement Agency with their secretary Miss Mary Sonoda and two colonels from a nearby airbase were the only Americans in attendance.

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Points of View

Sequoia and Pseudotsuga Name Changes in the 1953 Forest Service Check List

It is with some trepidation that the writer enters a discussion on the nomenclature of trees. Perhaps that hornet's nest should be left undisturbed. However, the urge to comment upon the recent *Check List of Native and Naturalized Trees of the United States*, Agriculture Handbook number 41, Forest Service, U. S. Department of Agriculture, is too strong to resist. This publication seems to be an excellent piece of work, and undoubtedly represents the culmination of much painstaking effort. The changes in nomenclature presented will perhaps receive approval from those who feel that strict adherence to the International Code is desirable.

In contrast, the professional foresters of the United States and Canada, who have been brought up on dendrological or botanical texts that used the more or less outdated American Code and have observed the changes appearing periodically since they left school, may perhaps be pardoned if they consider these changes an annoying if inevitable sign of progress. If we could be assured that the publication under discussion, and others like it elsewhere in the world, would be considered more or less final, perhaps some of us would not be so perturbed. But how long must these important changes continue? Over the years, how much time and effort are to be expended in searching obscure literary tomes for some printer's error or other overlooked mistake which must result, according to rules, in a rather "world shaking" name change such as that presented in this book for the well established *Pseudotsuga taxifolia* (Poir) Britt.?

According to recently published bibliographical research, in rigorous adherence to the rules we must now officially call this great timber species *Pseudotsuga menziesii* (Mirb.) Franco. The professional forester has no quarrel with the taxonomist or systematic botanist who justifies name changes on the basis of international agreement, in order that uniformity, clarity, and ultimate reasonable stability may be achieved. However, where is the dividing line to be placed between critically important changes that clarify real confusion and troublesome changes that appear to be based on highly technical publication detail no longer a source of ambiguity in names? It may be said in rebuttal that the professional specialist and the practising forester will inevitably have divergent views, and in the long run the latter will have to bow to the professional taxonomists in the interests of pure science. Nevertheless, the writer believes that the authors of this latest check list have been inconsistent in application of the International Code of Botanical Nomenclature. This is well illustrated by the discussion of the name for *Sequoia gigantea* (Lindl.) Deene. Quoting the above mentioned publication, page 402:

> The name *Sequoia gigantea*, which is in general use for the giant Sequoia, is adopted here, though *S. washingtoniana* was used in the 1927 Check List and *S. wellingtonia* has been the proper name since 1930 under the International Code of Botanical Nomenclature. A majority of the botanists in California consulted prefer to continue the illegitimate name *Sequoia gigantea*, which is so well established in many publications about these remarkable trees. In the interests of uniformity and of the elimination of confusion in names, the name *S. gigantea* is accepted here by the Forest Service Committee.
>
> Buchholz (Amer. Jour. Bot. 26:535-538. 1939) segregated this species from Sequoia under the new genus *Sequoiadendron* as *Sequoiadendron giganteum* (Lindl.) Buchholz. However, under conservative taxonomy, division of a long established genus of only two living species to form two monotypic genera would not seem desirable nor necessary to emphasize the differences of the two species and would cause confusion in the identification of the many fossil species.

Further comment is made on the inappropriateness of Winslow's two names, with which we are not concerned here. Now, the undersigned has no objections to leaving the name of the giant Sequoia as this list proposes, but he does take issue with the reasoning imposed. In the first place, why give so much attention to this species as a special case in naming? If the reason for changing Douglas-fir (as well as for making *Abies nobilis* now *A. procera*, and *Abies venusta* now *A. bracteata*) is to adhere to the International Code, why not change the name of the giant Sequoia to *Sequoia wellingtonia* (which admittedly has been the correct name according to the International Code since 1930), and let the chips fall where they may? Regarding the change proposed by Buchholz, one may argue that the case he makes for putting the giant Sequoia into a separate genus from the coast redwood is certainly commendable, although opinions in this matter may vary. The name *Sequoiadendron giganteum* would appear to be a good "out" for those botanists who do not desire to accept the name *S. wellingtonia*, and yet wish to adhere to the formality of the International Code of Botanical Nomenclature. However, the argument concerning confusion in the identification of fossil species seems a poor one, at least in view of the resultant confusion already apparent in this field subsequent to the realization that many of the fossils formerly referred to as Sequoia are in reality probably not that, but Metasequoia.

The decision to use an "illegitimate" name for the giant Sequoia, based on a "Gallup poll" type of plebiscite among California botanists, makes some of us in this region feel overlooked in not having an equal opportunity to elect an illegitimate name for Douglas-fir! If the main aim is to avoid confusion, consider for a moment the

effect of eliminating *Pseudotsuga taxifolia*. As far as commercial forestry is concerned this is one of our really extensive species. (Even in California, the Douglas-fir is incomparably more important in the timber industry no matter how much we admire the giant Sequoia as a tree.) Such a change affects not only the silviculturists both here and in Europe where the species is being used increasingly in forest planting, but also those workers in the fields of forest products and wood chemistry where technical names for extractives are frequently based on the well established scientific name. "Taxifolin" is the perfect example of this.

One may counter that these matters of synonymy may be straightened out by a scholarly study of the literature. But this costs money and time and it would seem that there are more important and productive fields for such researchers than reorganizing past thinking and work. If any opinion poll had been taken among the foresters, or perhaps even the botanists of the Pacific Northwest, there would probably have been a healthy yelp of protest. Parenthetically, it may be added, that the appropriateness of the new scientific name "menziesii" is acknowledged, since as a member of Vancouver's expedition, Archibald Menzies was the original collector of the species. Appropriateness of names, however, is not the issue. Names are important, a universal code is essential, clarity and uniformity and consistency are admirable, but is there not also a place for consistent good judgment in considering the relative importance of making changes such as that involved in altering at this date. *Pseudotsuga taxifolia* to *P. menziesii?*

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Jack Pine. *From the painting by A. Y. Jackson, commissioned by the Canadian Pulp and Paper Association. One of a series of forest scenes by distinguished artists, depicting the chief forest species presently harvested by that industry for pulpwood.*

Reviews

Forest Mensuration

By H. Arthur Meyer. 357 pp. Illus. Penns Valley Publishers, Inc., State College, Pa. 1953. $6.50.

In this noteworthy textbook on mensuration in American forestry, Meyer has undertaken a fresh approach to this old and basic subject. The result is a sound and objective treatment that should please both student and teacher. It is an elementary text for beginners rather than a reference book for advanced students.

Part I lays the foundation, sketches material covered, and should impress the reader with the basic simplicity of the material. Part II describes the common applications of measurement procedures in forest inventory: measuring logs and trees. On 150 pages, the essentials of practical scaling and cruising are clearly stated in a manner that also shows significant interrelations. Part III contains a lucid description of methods of growth determination, with emphasis on the elements of growth. Part IV is concerned with structure and growth of stands and so relates mensuration to management by presenting methods of determining the allowable cut. And finally there is an appendix of nine tables useful in measuring trees and stands.

A few points warrant specific mention.

The use of free hand curve fitting has been frequently deplored by mathematically inclined mensurationists. It is noteworthy that Meyer accepts this method of fitting (chapter 5, page 105), especially in view of his article (Jour. Forestry 38:415-420, 1940) describing a mathematical solution of this same problem.

The illustration and introduction to least squares, on page 122, would have been easier without logarithms. The elementary student of mensuration, for whom this book is written, would find it easier to accept: $V = a + bD^2$ as an introduction. And essentially the same story could be told.

The use of aerial photographs in cruising (chapter 7, page 156) emphasizes delineation of classes on the prints, while the method described in chapter 9, page 212, uses classified plots, essentially points. In failing to compare the alternatives with and without delineation, an opportunity to clarify a muddled situation was missed. Delineation is superior for the location of stands while point classification is more efficient to obtain an estimate of total volume.

It is gratifying to see limits and classes of d.b.h. properly handled (chapter 8, page 174 and chapter 12, page 253): trees field tallied by two inch classes use even inches as class values (8, 10, 12, . . .) while their corresponding limits are 7, 9, 11, . . . Trees measured in the field to the nearest tenth, and so recorded, must use this tenth inch in grouping as 7.0 to 8.9 with a class value of 7.95 (or 7.6 to 8.5 with a class value of 8.05). These distinctions are important, as failure to observe them leads to systematic error, but some foresters are confused on this matter of diameter classes.

An ingenious adaptation of $S^2/x = S^2/N$ is used (chapter 8, pages 188-196) to describe how to obtain the sampling error of a cruise: area is substituted for number. This is an assumption, so far as I know. One would expect it to be true insofar as adjoining small areas are independent. This assumption is also related to the footnote on page 207. As Johnson and Hixon use the commonly accepted definitions, it is unfortunate that more effort was not made to reconcile these viewpoints and thus, perhaps, minimize the misunderstanding that may ensue.

The problem of site quality is discussed on three pages under even-aged management (chapter 14, pages 292-295), but is omitted entirely in chapter 15 on uneven-aged stands. This omission provokes questions: is there no variation in site? Or is there no satisfactory measure of site quality without age? A paragraph here would have been helpful and valuable to the beginner in forest mensuration to improve his over-all understanding, at least.

There are other minor details that could be challenged. But the overall impression is still favorable. In general Meyer has put mensuration in its place as a means of obtaining desired measurement data. It is a tool and he has done well in telling how to use it. This book should make it easier to teach and to learn the techniques of forest mensuration.

C. Allen Bickford

Tropical Woods and Agricultural Residues as Sources of Pulp.

F.A.O. Forestry Products Studies No. 3. 190 pp. Columbia University Press, New York 27. 1952. $2

The fifth meeting of the F.A.O. Technical Committee on Wood Chemistry was held at the Institute of Paper Chemistry in Appleton, Wis., September 17 and 18, 1951.

This publication, which contains the papers presented at this meeting, is divided into two parts. Part I deals with tropical woods as sources of pulp and Part II is concerned with agricultural residues as sources of pulp. These are the two greatest available fibrous reservoirs in the world.

In the symposium on tropical woods, one session was concerned with the availability, nature, physical, chemical and fiber characteristics of the woods making up at least a part of the tropical forests. These are principally hardwoods. The authors of these chapters are R. W. Hess, F. F. Wangaard, L. E. Wise, and I. H. Isenberg. A considerable portion of the data reported herein resulted from research studies sponsored by the Office of Naval Research. This sponsored research conducted at Yale University and the Institute

of Paper Chemistry has certainly stimulated thinking in the United States on the properties of the tropical woods.

Also included in the first session was a comprehensive article on species (*Eucalyptus regnans*) sampiling on a reproducible basis by several officers in the Commonwealth Scientific and Industrial Research Organization, Australia. A second session related to the problems involved in the pulping of these woods as experienced by several investigators. Pulping studies on species from Africa, Central and South America, Australia, and India were reported by R. Peteri, H. E. Coomber, R. O. H. Runkel, A. Meller, R. H. Farmer, W. G. Campbell, L. Rys, G. Aron, W. Overbaeck, F. A. Simmonds, R. M. Kingsbury, and R. V. Bhat.

The information in these eight chapters chiefly concerns the pulping of hardwood by several processes for various purposes and the properties of these pulps, but there is a report on a detailed study of the influence of chipping on the properties of Parana pine sulfite pulp.

Part II presents five chapters dealing with agricultural residues as sources of pulp. E. C. Lathrop discusses the characteristics of pulp fibers from agricultural residues; L. G. S. Hebbs considers cereal straw pulping in the United Kingdom; F. M. Muller reports on developments in straw pulping in the Netherlands; S. I. Aronovsky describes recent advances in pulping straw in the United States; and A. S. Kasser elaborates on modern industrial pulping of straw and bagasse. It is worth noting that in an earlier chapter, R. V. Bhat reported on chemical pulps prepared from several species of reeds and grasses found in large quantities in some parts of India.

The Forestry Division of the Food and Agricultural Organization of the United Nations is to be commended for publishing, in such usable form and in their entirety, the carefully prepared contributions of the many experts who presented these papers at the meeting. These articles deserve to be widely read especially by those interested in the utilization of fibrous raw materials.

I. H. ISENBERG

Fables for Foresters

By John D. Guthrie. 64 pp. Illus. Forestry Enterprises, Washington, D. C. 1953. $3.50.

The easiest way to explain what this book is about is to quote the author. Says he, "this collection is an attempt to present the lighter or human side of the life of the forester and the forest ranger. Perhaps this human side needs to be emphasized, now that the foresters seem to have become more technically or research-minded; perhaps some of us foresters are beginning to take ourselves too seriously. At heart the forester and the forest ranger are still human, — and not machines.

"In many of these fables the foresters grouse a bit or poke fun at the routines and details of their daily work and problems. Any profession or organization that occasionally can make fun of itself is a live organization or profession. It is hoped therefore that these Fables may amuse,—if not instruct."

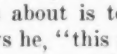
Most, though by no means all, of the sketches are by old-timers in the Forest Service. Some of these men, like the author, are retired; others are dead and gone. The fact that the book is thus somewhat dated does not detract from its fascination. As with furniture, a period piece in literature may have twice the interest of a modern production.

It is only fair to add that this collection will not appeal to everyone. These vagrant pieces were written not as literature, or for posterity. They are ephemeral attempts at humor and satire by men with an hour to kill, pencil and paper conveniently at hand.

As with his previous books, notably *The Forest Ranger and Other Verse* (1919) and *Forest Fire and Other Verse* (1929), Major Guthrie has preserved a segment of American forestry lore that otherwise might have been lost forever. Bless him for that!

Legend tells us that Aesop, the master fabulist of all time, used fables to convey moral lessons and useful bits of wisdom. Major Guthrie's modest tome is in that tradition. Those who don't like fables are advised to avoid it; those who do, are urged to read, perchance to buy. I did, and I'm glad.

HENRY CLEPPER



Wildlife in Alaska

By A. Starker Leopold and F. Fraser Darling. 129 pp. Illus. The Ronald Press. New York, N. Y. 1953. $2.75.

Publication of a scientific report in popular form is an accomplishment of sufficient infrequency in wildlife management to merit attention. If the report presents, as does this one, a subject of wide interest in a style conducive to reading in a single evening, it may be classed as a milestone in its field.

When the Conservation Foundation engaged F. Fraser Darling and A. Starker Leopold to survey wildlife problems in Alaska during the summer of 1952, in cooperation with the Department of the Interior, the announcement evoked little enthusiasm among old-timers who had weathered past activities of "six-months sourdoughs." It should, therefore, be a welcome assurance to note the humility with which the authors approached their assignment and defined the limitations of themselves and their report by stating, "Our task, as greenhorns spending four months in 586,000 square miles of territory, has not been to attempt to solve the problems of conservation in Alaska, but to make an objective appraisal of them."

Although the appraisal is less inclusive than indicated by the title, it gives comprehensive coverage of conservation problems relating to caribou, reindeer, and moose; reasonably adequate attention to blacktailed deer, Dall sheep, and mountain goats; and brief comments on

elk, bison, and bears. Specific discussions of these big game animals are preceded by excellent analyses of the challenging opportunities for wildlife conservation in Alaska, the relationships between wildlife and other territorial resources, and the vital ecologic and economic integration of wildlife and native peoples. A concluding summation points out the need for improved coordination in handling game, forage, and conservation education, especially among the Indians and Eskimos.

In a brief treatment of such a complicated subject it is difficult to avoid generalization and simplification. The authors have recognized this notably in their consideration of the involved socio-ecological relation between natives and wildlife. It is somewhat difficult, however, to reconcile the flat statement that the reindeer experiment "failed through lack of foresight and interpretation of range conditions." with the lengthy speculations on possible sociological factors. It should be rather obvious that the experiment was foredoomed to failure in its initial stages regardless of economic and ecologic factors. A pure hunting culture does not change to a pastoral culture in one or two generations, even with government fiat. Now, in the third generation, a change is beginning to appear, and the ecology and economics may become dominant.

Although this book is well documented by references which reflect careful search into sources not readily available to most readers, it contains a number of conclusions concerning which additional search would have been desirable, and others which may be questioned as to feasibility. The first is exemplified by the authors' comparison of records prior to 1925 with those of the present to show a declining caribou population on the Arctic slope, whereas a complete citation of aerial counts would have shown a pronounced and abrupt decline in population during recent years, amply sufficient to support justification of an emergency control of predators in the Umiat area.

An example of the second category is seen in the suggestion for increased control and use of fire as a range improvement measure, in lieu of expenditures for caribou herd improvement through law enforcement and predator control. The need for greatly expanded fire control on subarctic ranges is universally recognized by all who are informed on the subject, but the logistics and economics of fire prevention and control near the Arctic present obstacles that to date have baffled both Canadian and Alaskan foresters. It is nevertheless stimulating to have attention focused upon the great need for such range improvement.

This is an opportune and challenging book, worthy of careful study by foresters, game managers, sportsmen, and all who are interested in the conservation resources in our last frontier area.

CLIFFORD C. PRESNALL

❦ ❦ ❦

Farm Woodland Management

By G. B. Shivery. 34 pp. Illus. Pub. No. 346, Agric. Ext. Service. Univ. of Tenn., Knoxville. 1953.

The big task of selling better woodland practices to the farmer continues. And this is the chore which Shivery accepts as he directs this publication to the farm leaders and woodland owners of Tennessee.

The author logically divides his publication into four parts and points out that a farm woods program consists of (1) protection against fire, grazing, insects and disease; (2) forest tree planting; (3) woodland improvement; and (4) harvesting and marketing.

Two pages of the publication are devoted to protection. Here the author uses the "standard" reasons why the woodland owner should keep fire out of the woods, protect it from grazing, and take measures to reduce the losses from insects and disease.

The topic "forest tree planting" is fully discussed, covering eight pages. Planting site requirements are given for ten commercial tree species. Instructions on planting time and methods are presented.

Woodland improvement, Shivery contends, is sorely needed in Tennessee. His seven-page analysis of this topic is divided into: (1) thinning, (2) liberation cutting, and (3) pruning. However, he makes only a passing reference to the use of herbicides such as 2-4-5-T, etc., in woodland improvement. Since the success of such chemicals is well demonstrated through research and field tests, it is felt that the author overlooked a good bet here.

Almost half of the publication is devoted to harvesting and marketing which are considered together as one general topic. This is a logical combination for as the author points out "these two practices are closely related and overlap . . . yet for a complete understanding of timber growing both need to be recognized as essential parts of farm woodland management."

With this basic reasoning, Shivery proceeds to tell the woodland owner: (1) how to find out what he has to sell; (2) how to size up his markets; and (3) how to cut in such a manner so that he can sell now and again within a few years.

This publication should prove valuable to teachers of vocational education, county agents, farm foresters, and also farmers who have the inclination to study it carefully.

MARLIN H. BRUNER

❦ ❦ ❦

Forest Regeneration in Ontario

By R. C. Hosie. 134 pp. Illus. University of Toronto Press, Toronto, Canada. 1953. $2.

Since Ontario stretches from New York State to Minnesota and has 110,000,000 acres of forest lands, the problem of obtaining regeneration following logging is a complex one.

In this bulletin, Prof. Hosie has summarized the results obtained by all known regeneration surveys in the province, 57 in number, over the period 1919-1951. Field observations by the author were made in 1949, 1950, and 1951 on all areas covered by the surveys and in other parts of the province where sur-

veys have not been made.

The work is submitted in two parts. "The first part presents a general view of the nature of tree reproduction on cutover forest land in the province, followed by an analysis of the procedure used in conducting and reporting regeneration surveys and by a statement of conclusions and recommendations. In the second part the abstracts of the surveys reviewed are arranged chronologically under the names of the agencies responsible for the original reports."

Those agencies were the Forestry Branch of Canada, the Ontario Department of Lands and Forests, the National Research Council, and various pulp and paper companies.

The study was sponsored and supported by the Research Council of Ontario.

It should be noted that the report deals almost exclusively with the pulpwood species, spruce and balsam. White, red, and jack pine receive only minor attention and the hardwoods are noted only in passing. This is, of course, understandable since most of the forest area lies within the boreal forest and pulpwood is the principal product.

This book should prove of value to anyone interested in the silviculture of spruce and balsam. It has application to others who are concerned with the procedures for making regeneration surveys.

Three recommendations are made by the author in concluding. The first may not receive unqualified support since it can be argued that the evidence submitted does not justify the recommendation made. However, there is no doubt that the second and third recommendations should receive due consideration by all agencies and individuals involved.

G. G. COSENS

Publications of Interest

The Department of Defense has just published, after two years of preparation, a manual, *Lumber and Allied Products*, designed to guide requisition writers, storekeepers, inspectors, and craftsmen employed by the military services to order the right kinds and qualities of wood products, inspect, tally, and store them properly, and use them to best advantage.

Separate sections of the manual describe the properties of the various wood species, explain grading of lumber, plywood, poles, piling, and other products, and outline the essentials of lumber inspection, tallying and storage, in addition to sections showing the proper filling out of requisitions for the actual purchase of wood. Emphasis is laid on adhering to regular commercial practices, so that wood products are procured through established trade channels.

Lumber and Allied Products was prepared for the Army Corps of Engineers, which procures wood products for the entire Department of Defense, by the U. S. Forest Products Laboratory, with the cooperation of the National Lumber Manufacturers Association, the various regional associations of lumber manufacturers, the plywood manufacturers' trade associations, and organizations representing producers of poles, piling, preservative-treated wood, railroad ties, and other products.

The manual may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., for $1.00 a copy.

* * *

A useful publication, *Directory of Organizations and Officials Concerned with the Protection of Wildlife and Other Natural Resources*, is available from the National Wildlife Federation, 232 Carroll Street, N. W., Washington 12, D. C., for 25 cents a copy, the Wildlife Management Institute reports.

* * *

Secretary of Agriculture Ezra Taft Benson, in a booklet *Strengthening American Agriculture Through Resource Conservation*, has emphasized the need for a "strengthened and improved" program of conservation of soil, water, range, and forest resources —"the foundation blocks in the structure of our national economy."

The booklet is one of a series of U. S. D. A. booklets outlining major policies and program objectives.

Three main resource-conservation jobs, listed by the Secretary, are: 1. Accelerate both research and education; 2. Improve technical aid to landowners and operators and help speed up the survey of soil resources and the planning and application of needed conservation measures on farm, ranch, and forest lands; and 3. Encourage local leadership such as is provided by soil conservation districts, watershed organizations, and other community and neighborhood teams of people.

The booklet may be obtained from the Office of Information, U. S. Dept. Agric., Washington 25, D. C.

* * *

Of interest to machine owners is the Caterpillar Tractor Co. publication entitled *The Story of Modern Service*.

This illustrated booklet discusses the service methods used by Caterpillar dealers both in the shop and in the field. Included in the booklet is a map of the U. S., Canada, and Mexico, showing the location of Caterpillar dealers, parts depots, and factories.

For a copy, contact any Caterpillar Dealer or Caterpillar Tractor Co., Peoria, Ill., and ask for Form D381.

* * *

The latest edition of the *Forest Products Research Guide*, published by the National Lumber Manufacturers Association, lists 17,000 research projects and programs conducted by nearly 3,000 domestic and foreign organizations.

The 386-page guide is published principally for the benefit of research laboratories, manufacturers, educators, students and libraries. It covers projects grouped according to major classifications in research and utilization of wood and other tree products.

It also contains a comprehensive listing of research agencies, according to the specific projects they have performed or are working on. These include colleges and universities, federal and state governments, individual companies, trade associations, professional societies and commercial laboratories.

This is the fifth edition of the guide and the first to be published since 1950. It is available from the National Lumber Manufacturers Association, 1319 Eighteenth Street, N. W., Washington 6, D. C., at $10.00 a copy.

* * *

A revision of *You Can't Argue with Weeds* has just been issued by the Chipman Chemical Company, manufacturers of chemical weed killers. This 40-page booklet contains information on a wide variety of chemicals currently recommended for weed, grass, and brush control. Information on killing brush, trees, and stumps is also included. A copy may be obtained by writing to Chipman Chemical Company, Inc. Dept. 22, Bound Brook, N. J.

Current Literature

Compiled by MARTHA MEELIG, *Librarian, State University of New York College of Forestry*

Range Management Section Compiled by FRANCES FLICK, *Library, U. S. Department of Agriculture*

General

Check List of Native and Naturalized Trees of the United States (Including Alaska). By E. L. Little. 472 pp. U. S. Forest Service, Washington 25, D. C. 1953. (U. S. Dept. Agric.) Agric. Handbook No. 41. (Supersedes Misc. Cir. No. 92.) $2.00 (Govt. Print. Off.).

Five Years of Research on the Fernow Experimental Forest, West Virginia. 44 pp. Illus. Northeastern Forest Expt. Sta., Upper Darby, Pa. 1953. Station Paper No. 61. Processed.

Growing Trees in a Free Country. 24 pp. Illus. The Forest Industries Council. 1953. Secretary: A. Z. Nelson, National Lumber Manufacturers Ass'n., Washington, D. C.

The Kane Experimental Forest. 4 pp. Northeastern Forest Expt. Sta., Upper Darby, Pa. 1953.

Those of the Forest. By W. B. Grange. 314 pp. Illus. Flambeau Publ. Co., Babcock, Wis. 1953. $4.75.

Farm Forestry

Developing Farm Woodlands. By J. F. Preston. 400 pp. McGraw-Hill, New York. Dec., 1953. Rural Activities Ser. $4.50.

The Well-Kept Farm Woods. (A Conservation Teaching Aid.) 12 pp. U. S. Dept. Agric., Washington 25, D. C. 1953.

Forest Economics

A Century of Lumber Production in California and Nevada. By R. H. May. 33 pp. California Forest and Range Expt. Sta., Berkeley. 1953. Forest Survey Release No. 20.

Forest Influences

The Ground Water Resources of Rhode Island: A Reconnaissance. By W. B. Allen. With a Section on Surface-Water Resources. By H. B. Kinnison. 170 pp. Illus. U. S. Geological Surv. in coop. with R. I. Devel. Council, Providence. 1953. Geol. Bull. No. 6.

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Area and Ownership of Forest Land in Santa Cruz County, California. By H. L. Baker and Adon Poli. 22 pp. California Forest and Range Expt. Sta., Berkeley. 1953. Forest Survey Release No. 21.

The Forest Resource of Hubbard County. 63 pp. Illus. Office of Iron Range Resources and Rehabilitation, St. Paul 1, Minn. 1953.

The Forest Resource of Wadena County. 58 pp. Illus. Office Iron Range Resources and Rehabilitation, St. Paul 1, Minn. 1953.

Forest Statistics for Grays Harbor Co., Washington. By F. L. Moravets. 24 pp. Pacific Northwest Forest and Range Expt. Sta., Portland, Ore. 1953. Forest Survey Rept. No. 111. Processed.

Forest Statistics for Lewis Co., Washington. By F. L. Moravets. 24 pp. Pacific Northwest Forest and Range Expt. Sta., Portland, Ore. 1953. Forest Survey Rept. No. 112. Processed.

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Kentucky's Forest Resources and Industries. By O. K. Hutchison and R. K. Winters. 56 pp. Illus. U. S. Dept. Agric., Washington 25, D. C. 1953. Forest Resources Rept. No. 7. 35 cents (Govt. Print. Off.).

Logging and Milling

The Air Drying of Engelmann Spruce. By E. C. Peck. 11 pp. Illus. U. S. Forest Products Lab., Madison, Wis. R1944-5. Mimeog.

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Logging Methods and Costs in the Southern Appalachians. By R. A. Campbell. 29 pp. Illus. Southeastern Forest Expt. Sta., Asheville, N. C. 1953. Station Paper No. 30. Processed.

Logging Safety . . . Extracts from Papers Presented at the Logging Safety Conference . . . Syracuse, N. Y., May 12 and 13, 1953. Sponsored by State Univ. of New York College of Forestry and Northeastern Loggers Ass'n., Syracuse. 1953. Mimeog.

Sawmill and Logging Residues in the South Carolina Piedmont; Problems and Methods of Salvage. By A. S. Todd, Jr. 32 pp. Southeastern Forest Expt. Sta. Asheville, N. C. 1953. Station Paper No. 31. Processed.

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Grasses Introduced into the United States. By F. C. Weintraub. 79 pp. Supt. of Docs., U. S. Govt. Print. Off., Washington 25, D. C. U. S. Dept. Agric., Agric. Handbook No. 58. 1953. 25 cents.

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Increasing Forage Yields and Sheep Production on Intermountain Winter Ranges. By S. B. Hutchings and G. Stewart. 63 pp. Illus. Supt. of Docs., U. S. Govt. Print. Off., Washington 25, D. C. U. S. Dept. Agric. Cir. No. 925. September, 1953. 20 cents.

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Growth, Mortality, and Regeneration After Cutting in Loblolly Pine Pulpwood Stands. By T. A. McClay. 14 pp. Illus. Southeastern Forest Expt. Sta., Asheville, N. C. 1953. Station Paper No. 28. Processed.

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Soil Temperatures in the South Carolina Piedmont. By G. E. Greene. 16 pp. Southeastern Forest Expt. Sta., Asheville, N. C. 1953. Station Paper No. 29. Processed.

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Wood Technology and Utilization

Beech for Flooring. By E. A. Lefkof. 11 pp. Illus. Northeastern Forest Expt. Sta., Upper Darby, Pa. 1953. Beech Util. Ser. No. 8. Processed.

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Society Affairs

Officers and Members of the Council, 1954-1955

E. L. Demmon, *President*
Southeastern Forest Experiment Station
Federal Building
Asheville, N. C.

DeWitt Nelson, *Vice President*
Department of Natural Resources
State Building 1
Sacramento, Calif.

Henry Clepper, *Executive Secretary*
Mills Building, 17th Street at Pennsylvania Avenue, N. W.
Washington 6, D. C.

William J. Brown
Woodlands Department
Kimberly-Clark Corporation
Neenah, Wis.

Stanley G. Fontanna
School of Natural Resources
University of Michigan
Ann Arbor, Mich.

Joseph S. Illick
State University of New York
College of Forestry
Syracuse 10, N. Y.

C. Huxley Coulter
Florida Forest Service
Tallahassee, Fla.

Percy D. Hanson
U. S. Forest Service
Federal Building
Missoula, Mont.

J. Herbert Stone
U. S. Forest Service
Post Office Building
Portland 8, Ore.

D. B. Demeritt
Dead River Company
6 State Street
Bangor, Me.

Edwin F. Heacox
Weyerhaeuser Timber Company
Tacoma 1, Wash.

Ruthford H. Westvelp
Department of Forestry
University of Missouri
Columbia, Mo.

Membership Increases During 1953

The activities of the Sections, schools, and members have resulted in a significant membership increase for 1953. With continued cooperation and coordination of membership efforts in the Society's office we look forward to an even greater increase by the end of 1954.

As of November 30, 1952 the membership was 9,085. Terminations during the year were 561, of which 388 (or less than five percent) were dropped for nonpayment of dues. Including 79 reinstatements, a total of 928 names were added to the membership list. Since 1949 the net membership increase has been 2,808 members. (See Table 3.)

In the overall 1953 increase is reflected the candidacies of 271 applicants for the grade of Junior Member from among forestry graduates of accredited schools of forestry. An additional 130 applications for the Affiliate grade were received from graduates of nonaccredited schools, making a total of 401 applications, or about thirty-five percent of the total number of graduates from all forestry schools. The total number of candidacies for all grades processed during 1953 was 1,543.

The number of Student Members continues to be high. As of November 30, 1953 there were 510; 430 students applying for this grade during the year. In the years of 1949-1952 the highest numbers of forestry students were graduated: 1950 (2,321), 1951 (1,564), 1949 (1,443), and 1952 (1,160). It should be noted that 1952 graduates dropped by fifty percent. The percentage of applications for Society membership, however, remains substantially the same. It is felt that this percentage can be maintained, although obviously the numerical return will not be as great as in the higher years of graduation.

The 1953-1954 membership campaign is off to a good start. It is already evident that by the end of 1954 a material increase in membership

Table 1.—Membership by Sections November 30, 1953

Section	Rank	Total	Junior	Member	Fellow	Affiliate	Associate	Student
1. Allegheny	7	580	280	228	4	12	16	40
2. Appalachian	6	625	307	272	4	16	6	20
3. Central Rocky Mountain	14	265	92	129		4	4	36
4. Central States	4	636	329	193	2	17	12	83
5. Columbia River	2	870	466	328	4	33	13	26
6. Gulf States	5	631	290	223	2	85	15	16
7. Inland Empire	17	196	98	78	1	9	4	6
8. Intermountain	18	180	66	101		2		11
9. Kentucky-Tennessee	19	174	70	89		7	5	3
10. New England	8	570	227	236	4	54	19	30
11. New York	11	374	144	174	4	14	15	23
12. Northern California	3	751	375	277	7	43	21	28
13. No. Rocky Mountain	17	196	92	93	1	1	1	8
14. Ozark	13	342	145	117	1	39	4	36
15. Puget Sound	9	503	233	183	4	40	8	35
16. Southeastern	1	896	532	257	2	34	16	55
17. Southern California	20	115	57	42	2	8	3	3
18. Southwestern	16	215	110	90		14	1	
19. Upper Miss. Valley	12	363	156	142	1	13	8	43
20. Washington	15	257	48	166	11	5	26	1
21. Wis.-Upper Michigan	10	383	172	156	2	34	13	6
No Section Affiliation[1]		251	127	113	6	3	1	1
Corresponding		64						
Honorary		15						
Total membership		9452	4416	3687	62	487	211	510

[1]Includes 75 inactive and other members in U. S. and foreign countries who have requested that they not be designated as members of any Section.

Table 2.—Comparative S.A.F. Membership, as of November 30

Grade	1952	1953
Fellow	62	62
Member	3563	3687
Junior	4245	4416
Student	550	510
Affiliate	381	487
Associate	213	211
Corresponding	58	64
Honorary	13	15
	9085	9452
Increase		367

TABLE 3.—S.A.F. MEMBERSHIP, FIVE-YEAR PERIOD
(As of November 30)

Year	Fellow	Member	Junior	Affiliate	Associate	Student	Honorary	Corresponding	Total
1949	48	3209	2921	207	193	...	13	53	6644
1950	57	3313	3471	224	201	...	12	52	7330
1951	54	3467	3861	269	206	550	13	55	8475
1952	62	3563	4245	381	213	550	13	58	9085
1953	62	3687	4416	487	211	510	15	64	9452

will be reflected. It is estimated that about forty percent of the men actively engaged in forestry work are not Society members. A check reveals that at least twenty percent of this number at one time or another were members of the Society. Consequently, there are as many prospective members (eligible for reinstatement) in this group as there are among those who have never been members of the Society. As an aid to the Sections to meet their suggested quotas, approximately 900 cards of recent graduates from accredited forestry schools (nonmembers of the Society) were sent to the Sections during December. Also sent to the Sections were the names of members who have been in the Junior grade for six or more years, and presumably eligible for automatic advancement.

Northern California Section Holds Winter Meeting

A decade of progress in California's north coast forest region was highlighted for 260 members and guests attending the annual winter meeting of the Northern California Section, S.A.F., San Francisco, Dec. 5, 1953.

Morning sessions included three topics: the forest resource, forest practices, and forest protection in the region. The afternoon featured reports on new products and manufacturing methods, the outlook for the future, and a business meeting. After cocktails, 185 members, guests, and their ladies attended a banquet at which James W. Tapp, executive vice-president of Bank of America, spoke on business prospects for the Pacific Coast.

North Coast timber resources were described by Arnold F. Wallen. He estimated current saw-timber volume as 119 billion board feet, and reported that more than 1,200 sawmills or woods operators are dependent on the forest.

Gray Evans, Hammond Lumber Co., reported on new developments in the 100-year-old redwood logging industry; and Larry Marshall, Dolly Varden Lumber Co., described current practices in Douglas-fir operations. Both speakers cited improved cutting practices and expressed some concern over mounting slash-disposal problems.

David S. Way, Redwood Region Conservation Council, outlined the educational program which has awakened the public to need for fire prevention. Harvey E. Zink, U. S. Forest Service, told how public agencies

FISCAL YEAR MEMBERSHIP CAMPAIGN

SECTION BOX SCORE

Section	Proposed 1954 quota	Applications received[1] February listing	Applications received[1] Total fiscal year
Allegheny	100	3	17
Appalachian	100	6	9
Central Rocky Mountain	45	4	12
Central States	110	7	38
Columbia River	140	2	13
Gulf States	105	6	12
Inland Empire	30	5	7
Intermountain	30	5	7
Kentucky Tennessee	30	1	1
New England	95	16	31
New York	65	2	12
Northern California	120	1	20
Northern Rocky Mountain	30	8	11
Ozark	55	3	21
Puget Sound	80	2	14
Southeastern	145	6	47
Southern California	20	0	0
Southwestern	35	2	2
Upper Mississippi Valley	60	11	38
Washington	45	0	3
Wisconsin-Upper Michigan	60	0	0
Total	1,500	90	315

[1]Student, Junior, Affiliate, Associate (initial) grades only.

FISCAL YEAR MEMBERSHIP CAMPAIGN

SCHOOL BOX SCORE

School	Student applications received February listing	Student applications received Total fiscal year
Alabama Polytechnic Institute	1	1
University of California	0	14
Colorado A & M College	3	10
Duke University	6	6
University of Florida	0	12
University of Georgia	0	17
University of Idaho	5	7
Iowa State College	1	20
Louisiana State University	5	5
University of Maine	10	10
University of Massachusetts	2	15
Michigan State College	3	11
University of Michigan	2	7
University of Minnesota	8	15
University of Missouri	0	16
Montana State University	7	7
State University of New York	0	8
North Carolina State College	0	0
Oregon State College	0	6
Pennsylvania State University	0	6
Purdue University	1	18
Utah State Agricultural College	5	7
University of Washington	1	11
West Virginia University	0	6
Yale University	0	0
Total	60	235

Let me do your
DRAFTING
Send me your rough field survey notes, pencil drafts, charts, etc. and I'll take care of the finished work. Professional quality backed by ten years experience in forestry mapping and in illustrating publications under the exacting requirements of large public agencies. Artwork, illustrations for manuscripts, posters, copywork.
Ask me for more details.
ROMOLA DROST
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and forest industries are cooperating to plan fire detection and control measures. Charles W. Fairbank, California Division of Forestry, described fire control programs.

New redwood products and manufacturing methods were described by Willard E. Pratt, California Redwood Association. New developments in Douglas-fir manufacture were reported by Ralph G. DeMoisy, M&M Woodworking Co.

At the business meeting, members passed resolutions calling for full staffing of the University of California's new forest products laboratory, and for addition of a forest entomologist and a forest pathologist to the university staff. John Zivnuska, chairman of the Section's standing committee on forest research, reported committee action in the fields of forest soils, aerial photography, forest regeneration, and experimental and demonstration forests.

C. M. WALKER

Necrology

December 1, 1952-November 30, 1953

Member

Beichler, William K., Garner, North Carolina.
Billard, Frederick H., Meriden, Connecticut.
Bittinger, Clarence A., Clarion, Pennsylvania.
Cecil, Charles L., Duluth, Minnesota.
Dean, Charles C., Bluffton, Indiana.
Favre, C. E., Reno, Nevada.
Kempff, Gerhard, Spokane, Washington.
Krell, F. C., Hazleton, Pennsylvania.
Linn, Edward R., Stillwater, Oklahoma
Lyford, C. A., Seattle, Washington.
Mottishaw, John S., Steilacoom, Washington.
Reynolds, Harris A., Boston, Massachusetts.
Rothery, J. E., Cotuit, Massachusetts.
Struhsaker, Fred P., Lansing, Michigan.
Tanner, Earl B., Portland, Oregon.
Weston, Ray F., Montrose, Alabama.

Junior

Coe, Arleigh, Otter Lake, Michigan.
Gehr, Cecil R., Los Angeles, California.
Neuns, Robert H., Berkeley, California.
Phelon, Richard F., Orono, Maine.
Rickman, Sterling H., Quinlan, Oklahoma.

Affiliate

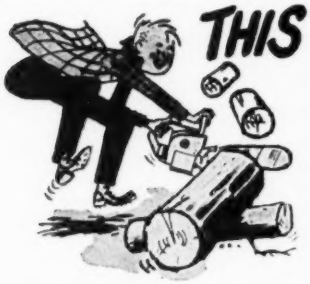
Howell, P. N., Howison, Mississippi.

Associate

Bombard, Dr. Miriam L., Washington, D. C.
Woolford, T. G., Atlanta, Georgia.

Honorary

Sutherland, John, Edinburgh, Scotland.



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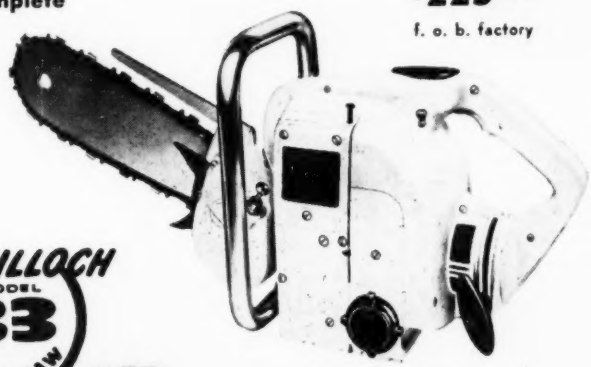

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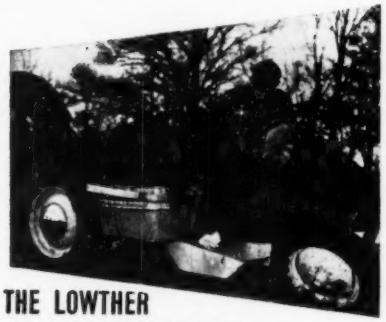

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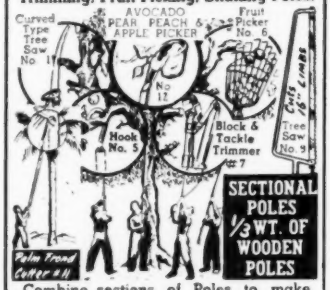
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Earl B. Tanner (1881-1953)

Earl B. Tanner, for some years member of the state board of forestry as representative of the Oregon Forest Fire Association, and one of the nation's top timber economists, died at his home in Portland, Oregon on November 28.

Although he had been in semi-retirement for several years, Mr. Tanner had attended the recent meeting of the National Lumber Manufacturers Association in Washington, D. C., where he was chairman of the committee on timber values and taxation.

Before Mr. Tanner went to Oregon in 1925, he was already well known for having directed the timber section of the U. S. Treasury Department, during the period of determining forest values under the then-new income tax law. He took an active interest in the forest protective associations, and was president of the Oregon Forest Fire Association for 14 years until 1951. He was an official of the company which started the first extensive logging operation in the Tillamook burn, and was official or director of several other timber companies. At the time of his death he was a director of the Booth-Kelly Lumber Company, of Eugene.

Mr. Tanner was a native of Nebraska, and was employed in the U. S. Forest Service for about ten years prior to World War I.

Walter W. Wetzel (1902-1953)

Walter Warren Wetzel, chief of range management in the California regional office of the U. S. Forest Service, San Francisco, died of a heart attack on December 1.

He was born October 3, 1902 at Collins, Missouri. He studied forestry at Montana State University and started work with the Forest Service as a guard in 1923, becoming a ranger in 1927. During World War II he was assigned to the Emergency Rubber Project in California.

Appointed forest supervisor in 1944 at Missoula, Montana, he was subsequently transferred to the Division of Operations at Portland, Oregon, and to the Division of Range Management at San Francisco.

Membership Applications and Advancements

Proposals for admission, advancement, and reinstatement received in the Society office during the month of December are listed below.

Action on the eligibility of those proposed for membership as listed below will be taken by the Council as of March 1, 1954. Communications from voting members regarding the membership eligibility of these persons should be received in the Society prior to that date.

Allegheny Section

Junior Grade

Ewers, J. F., Asst. Dist. Forester, Pa. Dept. of Forests and Waters, Fayetteville, Pa.; Pa. State, B.S.F., 1949.

Schomaker, C. E., Grad. Asst., Pa. State, State College, Pa.; B.S.F., 1950.

Member Grade

Bates, J. T., Cons. Forester, R.F.#2, Ligonier, Pa. (Junior, 1947).

Bennett, J. C., Buyer, J. Martin Apgar Co., North East, Md.; Univ. of Maine, B.S.F., 1948. (Junior, 1949).

Bethlahmy, N., Research Forester, U.S.F.S., Bethlehem, Pa. (Junior, 1947).

Brooks, M. G., Instructor, Div. of Forestry, W. Va. Univ., Morgantown, Pa. (Junior, 1947).

Carr, C. R., Rgr., U.S.F.S., Petersburg, W. Va. (Junior, 1946).

Church, T. W., Research Forester, Beltsville Exp. Forest, Laurel, Md. (Junior, 1947).

Clark, T. G., Cons. Forester, Box 1046, Morgantown, W. Va. (Junior 1947).

Corlett, W. S., Dist. Forester, Dept. of Forests and Waters, Blain, Pa. (Junior, 1947).

McClung, L. D., Asst. State Forester, Romney, W. Va. (Junior, 1946).

McNees, W. A., Chief Forester, Olga Coal Co., Coalwood, W. Va. (Junior, 38R47R50).

Ramsey, J. P., Plant Engr., Pittsburgh Consolidated Coal Co., Canonsburg, Pa. (Junior, 1947).

Smith, R. W., Forester, Hacker Valley Lbr. Co., Hepwood, Pa. (Junior, 1947).

Affiliate Grade

Sawyer, R. B, Lbr. Grader, J. Martin Apgar, North East, Md.; Univ. of N.H., B.S., (Forestry), 1948.

Appalachian Section

Student Grade

DUKE UNIVERSITY

Goforth, M. H. — Whitaker, H. F.
Hudson, M. D. — Worst, R. H.
Olinger, H. L. — Zimmerman, J. D.

Junior Grade

Flick, A. W., Sales Trainee, U. S. Plywood Corp., Richmond, Va.; L.P.I., B.S., (Forestry), 1951. (Affiliate, 1951).

Terrell, N. K., Asst. Dist. Forester, Fairfield Forest Products Co., Newberry, S. C.; Univ. of Florida, B.S.F., 1949. Reinstatement.

Member Grade

Buchholz, R. C., Mgr., Draper Corp., Asheville, N. C. (Junior, 1947).

Doolittle, W. T., Forester, Bent Creek Exp. Forest, Asheville, N. C. (Junior, 1947).

Shepherd, W. O., Chief, Div. Range Mgmt., S. E. Forest Exp. Sta., Asheville, N. C. (Junior, 1947).

Central Rocky Mountain Section

Student Grade

COLORADO A & M COLLEGE

Flamm, B. R. — Hoefer, J. F.
Goll, C. E.

Junior Grade

Yasinski, F. M., Ento., Forest Insect Lab., Ft. Collins, Colo.; State Univ. of N. Y., B.S.F., 1951; M.S, 1952.

Central States Section

Student Grade

MICHIGAN STATE COLLEGE

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Quick, D. L.

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PURDUE UNIVERSITY
McCarthy, M. J.
UNIVERSITY OF MICHIGAN
Buck, B.B. McArdle, J. P.

Junior Grade

King, E. G., Grad. Student, Purdue Univ., W. Lafayette, Ind.; Purdue Univ., B.S.F., 1952.

Lhotka, F. H., 1916 South 56th Ave., Cicero, Ill.; Iowa State, B.S.F., 1953. (Student, 1953).

Member Grade

Deitschman, G. H., Forester, U.S.F.S., Carbondale, Ill.; Univ of Minn., B.S.F., 1947; Pa. State, M.F., 1948. (Junior, 1947).

Jokela, J. J., Forest Research Asst., Dept. of Forestry, Univ. of Ill.; Urbana, Ill.; Univ. of Minn., B.S.F., 1947; M.S., 1951. (Junior, 1947)

Columbia River Section

Junior Grade

Hootman, W. D., Forester, Bur. of Land Mgmt., Coos Bay, Ore.; Iowa State, BS.F., 1948.

Knupp, W. W., Logging Engr., South Fork Lbr. Co., Sweet Home, Ore.; Univ. of Mich., B.S.F., 1943.

Member Grade

Gangle, L. C., Forester, Bur. of Land Mgmt., Coos Bay, Ore.; Oregon State, B.S.F., 1939. Reinstatement.

Loeb, J. H., Tree Farm Supv., Longview Fibre Co., Longview, Wash.; Univ. of Mich., B.S.F., 1947. (Junior, 1947).

Zaidlicz, E., Forester, Bur. of Land Mgmt., Roseburg, Ore.; Iowa State, B.S.F., 1949. (Junior, 1949).

Gulf States Section

Student Grade

LOUISIANA STATE UNIVERSITY
Cabaniss, G. W. Parker, R. L.
Lewis, A. D. Simmons, J. E.
McDaniel, O.

Junior Grade

Hamm, M. F., 3278 Ivanhoe, Baton Rouge, La.; La. State Univ., B.S.F., 1953 (Student, 1951).

Tobin, W. T., Forester, U.S.F.S., Rolling Fork, Miss.; Mich. State, B.S.F., 1950. Reinstatement.

Affiliate Grade

Flowers, W. H., Forester, Masonite Corp., Laurel, Miss.; Univ. of Wyo., B.S. (Game Mgmt.), 1949.

Inland Empire Section

Student Grade

UNIVERSITY OF IDAHO
Almas, D. P. Stolaas, H. L.
Jepsen, S. M. Tagawa, T. K.
Smith, L. O.

Intermountain Section

Student Grade

UTAH STATE AGRICULTURAL COLLEGE
Coghill, W. S. Watts, W. J.
Elder, F. S. Wolfe, M. L.
Wardleigh, R. D.

Kentucky-Tennessee Section

Junior Grade

Curry, J. A., Forester, T.V.A. Div. of Forestry Relations, Paris, Tenn.; Univ. of Mich., B.S.F., 1951.

Member Grade

Camisa, L. H., Forester, Bowaters Southern Paper Corp., Kingston, Tenn. (Junior, 1946).

Fechner, G. H., Forester, T.V.A., Norris, Tenn. (Junior, 1947).

Muller, G., Forester, Woods Dept., The Mead Corp., Kingsport, Tenn. (Junior, 1947).

Sharp, J. B., Jr., Prof. of Forestry, Univ. of Tenn., Fountain City, Tenn. (Junior, 1947).

Warmbrod, J. G., Asst. Ext. Forester, Tenn. Ext. Service, Jackson, Tenn. (Junior, 1947).

New England Section

Student Grade

UNIVERSITY OF MASSACHUSETTS
Galloway, F. L. White, E. F.
UNIVERSITY OF MAINE
Bennett, W. F. Seufert, E. C.
Bowman, P. C. Steffens, J. D.
Dyer, H. L. Walker, J. D.
Mawson, J. C. Weiland, F. W.
Rule, W. W. Zai, L. E.

Junior Grade

Erickson, N. D., Salesman, Sawyer Lbr. Co., Worcester, Mass.; Univ. of Maine, B.S.F., 1952.

Potter, S. W., Research Assoc., Harvard For-

est, Petersham, Mass.; Univ. of Mich., B.S.F., 1951; State Univ. of N. Y., M.F., 1951.

Affiliate Grade

Heitmann, A. F., Dist. Forester, Vermont Forest Service, Rutland, Vt.

Powell, L. M., Operations Inspt., Great Northern Paper Co., Brewer, Maine.

New York Section

Junior Grade

Guenther, R., Sales Trainee, Tide Water Assoc. Oil Co., Saranac Lake, N. Y.; State Univ. of N. Y., B.S.F., 1952.

Lake, G. T., Jr., Lbr. Business, Crown Point, N. Y.; State Univ. of N. Y., B.S.F., 1938.

Northern California Section

Junior Grade

Dick, W. E., Jr., Tbr. Cruiser, C. H. Bunting Cons. Forester, Redding, Calif.; Univ. of Calif., B.S.F., 1951.

Hunt, B. B., Forest Tech., Calif. Div. of Forestry, Redding, Calif.; Utah State Agric. College, B.S.F., 1941. Reinstatement.

Member Grade

Colwell, R. N., Assoc. Prof., Univ. of Calif., Berkeley, Calif., (Junior, 1947).

Cosens, R. D., Forester, Soper-Wheeler Co., Strawberry Valley, Calif. (Junior, 1947).

Dircksen, N. E., Staff Asst., Stanislaus Natl Forest, Sonora, Calif. (Junior, 1946).

Fairbank, C. W., Deputy State Forester, Calif. State Div. of Forestry, Santa Rosa, Calif. (Junior, 1947).

Lockhart, J. S., Rgr., Calif. State Div. of Forestry, San Andreas, Calif. (Junior 1946).

Toler, I. E., Forester, Scott Lbr. Co., Burney, Calif. (Junior, 1947).

Northern Rocky Mountain Section

Student Grade

MONTANA STATE UNIVERSITY

Chamberlin, J. L. — Stolle, P. C.
Gilliam, J. J. — Williams, D. V.
Jaszkowski, R. T. — Wright, G. G.
Kiser, F. E.

Member Grade

Drummond, D. M., Asst. Prof., School of Forestry, Mont. State Univ., Missoula, Mont.; Utah State Agric. College, B.S.F., 1937; La. State Univ., M.E., 1939. Reinstatement.

Sieminski, J. S., Forest Engr., c/o J. Neils Lbr. Co., Rexford, Mont.; Mont. State Univ., B.S.F., 1950. (Junior, 1950).

Affiliate Grade

Wilson, J. E., Forestry Aide, Lolo Natl. Forest, Missoula, Mont.

Ozark Section

Junior Grade

Hanson, N. F., U. S. Army, Ft. Sill, Okla.; Iowa State, B.S.F., 1950.

Peterson, M. A., Asst. Dist. Supv., The Crossett Co., Monticello, Ark.; Univ. of Minn., B.S.F., 1949.

Affiliate Grade

Gates, M. A., Forestry Aide, U.S.F.S., Hot Springs, Ark.; Ark. A & M., B.S., (Forestry), 1953.

Puget Sound Section

Student Grade

UNIVERSITY OF WASHINGTON

Radnich, J. C.

Member Grade

Byers, A. M., Woods Supt., Alaska Pine and Cellulose, B.C., Canada. (Junior, 1947).

Colwell, J. R., Cascade Lbr. Co., Ellensburg, Wash. (Junior, 1947).

Jones, R. W., Cons. Forester, Route 2, Bellevue, Wash. (Junior, 1946).

McNeil, R. L., Asst. to Staff Forester, Snoqualmie Natl. Forest, Seattle, Wash. (Junior, 1947).

Merryman, S. G., Forester, C. M. Berry, Photogrammetric Engrs., Seattle, Wash.; Univ. of Wash., B.S.F., 1950. (Junior, 1950).

Sedlacek, E. S., Forest Warden, Ranier Forest Protective Assn., Elbe, Wash. (Junior, 1947).

Wilson, J. E. Logging Engr., Snoqualmie Falls Branch, Weyerhaeuser Tbr. Co., Snoqualmie Falls, Wash. (Junior, 1946).

Associate Grade

Backstrom, R. V., Western Agric. Dev. Agent, Great Northern Railway Co., Seattle, Wash.; Univ. of Minn., B.S., (Agric.), 1932.

Southeastern Section

Student Grade

ALABAMA POLYTECHNIC INSTITUTE

Davis, B. A.

Junior Grade

Brislin, H., Jr., Forester, Gulf Lbr. Co., Mobile, Ala. La. State Univ., B.S.F., 1950.

Gregory, A. H., Forester, Gair Woodlands Corp., Savannah, Ga.; W. Va. Univ., B.S.F., 1950.

Knott, O. L., Jr., Asst. Chief, Information and Education, Ga. Forestry Comm., Atlanta, Ga.; Univ. of Ga., B.S.F., 1949.

Macke, W. J., 2809 Circle Drive, Bessemer, Ala.; A.P.I., B.S.F., 1953.

Smith, J. E., Tbr. Estimator, Tenn. Coal and Iron Div., Fairfield, Ala.; A.P.I., B.S.F., 1949.

Member Grade

Baxendale, H. E., Stapleton, Ala. (Junior, 1947).

Bailey, R. W., Forest Mgr., Union Bag and Paper Co., Darien, Ga. (Junior, 1947).

Blanks, P. S., Salesman, Forestry Equipment Co., Macon, Ga. (Junior, 1947).

Brogdon, E., Box 362, Lyons, Ga. (Junior, 1947).

Butler, J. L., Southern Plywood Mfrs. Assoc., Atlanta, Ga. (Junior, 1947).

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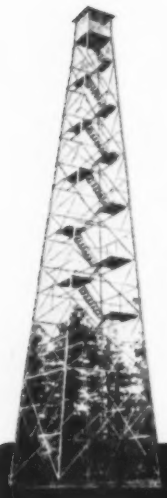

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American Cancer Society

Cooper, R. W., Olustee Exp. Forest, Olustee, Fla. (Junior, 1947).
Dunaway, G. R., P. O. Box 124, Molino, Fla. (Junior, 1947).
Eckerson, A., Jr., Woodlands Div., Union Bag and Paper Corp., Savannah, Ga. (Junior, 1947).
Fulmer, F. E., P. O. Box 176, Claxton, Ga. (Junior, 1947).
Hargreaves, L. A., Jr., Asst. Prof. of Forestry, Univ. of Ga., Athens, Ga. (Junior, 1947).
Hargrove, J. Z., Jr., Land Appraiser, Federal Land Bank, Columbia, S. C. (Junior, 1947).
Hinely, E. A., Box 111, Hazlehurst, Ga. (Junior, 1947).
Hudson, S. K., Box 335, Fernandina, Fla. (Junior, 1947).
Janel'e, H. W., Dist. Egr., Talladega Natl. Forest, Talladega, Ala. (Junior, 1947).
Johnson, J. W., Box 570, Savannah, Ga. (Junior, 1946).
Kinne, S. B., Jr., Forester, Union Bag and Paper Co., Pooler, Ga. (Junior, 1947).
Lavely, C. E., 18 Harlan Drive, Savannah, Ga. (Junior, 1947).
Manuel, S. F., Otter Creek, Fla. (Junior, 1947).
Martin, E. D., Parkersburg, Ga. (Junior, 1947).
Mathias, H. B., Land Mgr., Rome Kraft, Rome, Ga. (Junior, 1947).
Mayfield, F. D., Dist. Rgr., Shoal Creek Rgr. Dist. Heflin, Ala. (Junior, 1947).
McComb, W. H., Asst. State Forester, Ga. Forestry Comm., Atlanta, Ga. (Junior, 1947).
McCord, R. D., Cons. Forester, 522 Woodlawn Ave., Calhoun, Ga. (Junior, 1945).
McKnight, E. A., Woodward Iron Co., Woodward, Ala. (Junior, 1947).
Moore, J. E., Box 1200, Tallahassee, Fla. (Junior, 1947).
Pruitt, A. A., Forester, Ga. Forest Farms, Inc., Washington, Ga. (Junior, 1947).
Richardson, J. P., Forester, Int. Paper Co., Mobile, Ala. (Junior, 1947).
Royal, D. C., Box 352, Selma, Ala. (Junior, 1947).
Spruiell, S. G., 1041 57th St. W., Birmingham, Ala. (Junior, 1947).
Stallworth, N. J., Naval Stores operator, Box 1114, Mobile, Ala. (Junior, 1947).
Witherington, O., Dist. Forester, Ga. Forestry Comm., Americus, Ga. (Junior, 1947).
Zak, B., Forest Path., U.S.F.S., Athens, Ga. (Junior, 1947).

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Lyngholm, D. H., Range Mgmt. Asst., Bur. of Indian Affairs, Chinle, Ariz.; Colo. A & M., B.S.F., 1950.
Rainwater, R. H., Rancher, Gladiola, New Mex.; Colo. A & M., B.S.F., 1951.

Member Grade

Childress, D. L., Staffman, Coronado Natl. Forest, Tucson, Ariz. (Junior, 1947).
Courtney, R. E., Staffman, Cibola Natl. Forest, Albuquerque, New Mex. (Junior, 1947).
Dearborn, L. S., Dist. Rgr., Gila Natl. Forest, Kingston, New Mex. (Junior, 1947).
Diggs, R. L., Staffman, Apache Natl. Forest, Springerville, Ariz. (Junior, 34R53).
Herman, F. R., Forester, Rocky Mt. Exp. Sta., Flagstaff, Ariz. (Junior, 1947).
Lavin, F., Staffman, Rocky Mt. Exp. Sta., Tucson, Ariz. (Junior, 1947).
Lusher, A. A., Forest Supv., Mescalero Apache Indian Reservation, Mescalero, New Mex. (Junior, 1947).
McDermaid, F. E., Staffman, Coconino Natl. Forest, Flagstaff, Ariz. (Junior 1947).
Prichard, L. A., Dist. Rgr., Santa Fe Natl. Forest, Las Vegas, New Mex. (Junior, 1947).
Stevens, D. C., Staffman, Lincoln Natl. Forest, Alamogordo, New Mex. (Junior, 1947).

Upper Mississippi Valley Section

Student Grade

IOWA STATE COLLEGE
Lutz, C. A.

UNIVERSITY OF MINNESOTA

Mielke, T. L.	Bendix, V. D.
Nepp, J. F.	Johnson, R. E.
Rodewald, J. S.	Kaiser, J. R.
Schernick, J. L.	Kerrick, M. A.

Member Grade

Hall, O. F., Instructor, Univ. of Minn., School of Forestry, St. Paul, Minn.; Oberlin College, A.B., (Botany and Chem.), 1943; Yale Univ., M.F., 1948. (Junior, 1949).

Affiliate Grade

Marshall, W. J., Forester, Div. of Forestry, State of Minn., Effie, Minn.; Univ. of Minn., B.S., (Wood Tech.), 1949.

Washington Section

Member Grade

Caporaso, A. P., Photo-Interpretation Proj., U.S.F.S., Washington, D. C. (Junior, 1947).
Pechanec, J. F., Chief, Div. of Range Research, U.S.F.S., Washington, D. C. (Junior 1947).
Presnall, C. C., Asst. Chief, Branch of Predator and Rodent Control, Dept. of Interior, Washington, D. C. (Junior, 1945).
Reichard, E. C., U.S.F.S., Washington, D. C. (Junior, 1947).
Wolf, R. E., Budget Examiner, Div. of Resources, Washington, D. C. (Junior, 1947).
Zirkle, J. J., Jr., 3012 Parkway Terrace Drive, Washington, D. C. (Junior, 1947).

Wisconsin-Upper Michigan Section

Member Grade

Anderson, A. J., U.S.F.S., Three Lakes, Wis. (Junior, 1945).
Burg, M. P., 122 S. 2nd St., Tomahawk, Wis. (Junior, 1947).
Halbach, J. L., Dist. Forester, Mackinac State Forest, Newberry, Mich. (Junior, 1947).
Hankum, A. S., Sauk City, Wis. (Junior, 1947).
Lutz, J. F., 449 Charles St., Madison, Wis. (Junior, 43R50).
Michael, T. F., Solon Springs, Wis. (Junior, 1947).
Moses, C. S., Forest Products Lab., Madison, Wis. (Junior, 1945).
Nelson, A. E., Hugo Sauer Nursery, Rhinelander, Wis. (Junior, 1946).
Salter, R. D., Equip. Supv., Cons. Water Power and Paper Co., Rhinelander, Wis. (Junior, 1946).
Van Arsdell, E. P., Dept. of Plant Path., Univ. of Wis., Madison, Wis. (Junior, 1947).
Von Bargen, J. H., 2306 W. Roosevelt Drive, Milwaukee, Wis. (Junior, 1947).
Ziemann, F. S., 220 East 10th, Kaukauna, Wis. (Junior, 1947).

Forestry News

Mid-Century Conference on Resources for the Future Held in Washington

The Mid-Century Conference on Resources for the Future was held in Washington, D. C., December 2-4. The three day meeting was for the purpose of examining the natural resources position of the United States and to discuss the probable developments to be anticipated during the next quarter century.

Former Ambassador Lewis W. Douglas, chairman of the board, Mutual Life Insurance Company of New York, and chairman of the conference, said at the close of the meeting that the conference had identified domains of agreement and areas of disagreement in the approach to natural resource problems, and that the exchange of views by a wide assortment of individuals of a great variety of skills and talents had clarified the reasons for disagreement in this field.

The conference, in which 1,472 industrialists, labor officials, businessmen, social and physical scientists, conservationists, officials of local, state and federal governments and foreign observers participated, was financed by a grant from The Ford Foundation.

It was initiated by Resources for the Future, Inc., a non-profit corporation devoted to research and education in the field of resources development and conservation. The conference reached no conclusions—there were no resolutions, and no votes. It was planned as a citizens' conference for free discussion of issues, and for the compilation of facts and opinions on which public and private agencies and groups might chart their plans and policies.

Most of the work of the conference was done in eight sections, meeting concurrently on various aspects of the resources problem. There were 118 participants in Section I (Competing Demands for Use of Land), 254 in Section II (Utilization and Development of Land Resources), 232 in Section III (Water Resource Problems), 106 in Section IV (Domestic Problems of Non-fuel Minerals), 170 in Section V (Energy Resource Problems), 157 in Section VI (U. S. Concern with World Resources), 126 in Section VII (Problems in Resource Research) and 125 in Section VIII (Patterns of Cooperation), plus 184 who attended various meetings, but registered for no particular group.

The opening session was a general meeting of the entire conference, for a panel discussion of a paper, *A Mid-Century Look at Resources*, prepared by The Brookings Institution as a basic approach to the general and specific problems. President Eisenhower greeted the participants at a luncheon on December 2, expressing his profound interest in conservation, which he defined as use without waste. There were panel discussions, also, at two general dinner meetings, Dec. 2 and 3, on control of public lands and world resources. The final session also was a general meeting at which summary reports were presented on the work of the eight sections.

The conference was the first major project of Resources for the Future, Inc., and Dr. Reuben G. Gustavson, president and executive director of the organization, indicated that its directors are now studying a number of proposed projects for future action.

". . . It shall be a part of Resources for the Future to make the most careful kind of studies," Dr. Gustavson told a luncheon meeting, "in order that we may make good judgments as to where this organization may place its funds in order to obtain the best return from the long-range point of view."

The profession of forestry was well represented at the conference, with foresters participating in discussions of most of the sections.

Nash Awards to Two Foresters

The first annual Nash Conservation Awards, ten to professional workers and ten to nonprofessional, include two foresters.

Dr. Charles R. Hursh, Asheville, N. C., research forester with the Forest Service, received a $500 award "for his outstanding research in the relation of soil and forest vegetation to streamflow and his establishment of a world-recognized hydrologic laboratory at Dillard, Ga." (Coweeta).

Charles A. Rindt, Portland, Ore., of the regional office of the Forest Service received a similar award "for his important contributions to forestry practices, including development of techniques for long-term tree seed storage and cold storage of nursery stock."

Each of the award winners in the class of professional workers received $500, while the awards to the ten nonprofessional conservationists were medals in recognition of their acts of good citizenship in fostering better conservation methods.

George W. Mason, president and chairman of the board of the Nash-Kelvinator Corp., Detroit, in explaining the significance of the awards, said: "The automobile industry has a stake in conservation because so much of the enjoyment of the outdoors depends upon the automobile. We hope this program will impress upon the public the wide scope and scientific nature of modern conservation."

Treasury Defines Management Practices For Loans

Recent amendment of the Federal Reserve Act was made to permit national banks to make real estate loans secured by first liens on forest tracts which are "properly managed in all respects." The Treasury Department statement clarifying this term is as follows:

"It is our interpretation that proper forest management in all respects is the application of suitable and economically sound forestry principles relating to protection, utilization, and reproduction of forest tracts, and the following are indicative of such management:

"a. Organized protection against forest fires is provided by the state forest service or other protective public or private fire protection agencies. Such protection shall include provision for prompt detection and suppression of forest fires and, where considered necessary by local foresters, presuppression measures such as construction of fire-breaks and fire-roads.

"b. In cases where hazards from attack by insects or diseases are unusually high, protection is provided by an effective public or private organization, or existing roads and logging conditions are such as to make salvage of killed timber feasible.

"c. Any cutting conducted during the period of the loan is of such nature

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as to insure reproduction and continued growth of timber tracts. Where a borrower follows the advice of a qualified person in timber marking for example, this would ordinarily indicate acceptable cutting practice.

"The amount of any such loan may not exceed 40 percent of the appraised value of the economically marketable timber offered as security, which means 40 percent of the value at the time the loan is made and not the value which it is estimated the timber will have at the time it is to be cut or at the maturity date of the loan. The loan balance may at no time exceed 40 percent of the original appraised value of the economically marketable timber then remaining, which means that as timber is cut at least a portion of the proceeds must be used toward payment of the loan if the maximum permissible loan were made at the outset.

"Forest tract loans may run for only two years, except that they may run for ten years if provision is made for amortization at a rate of at least 10 percent per annum.

"Forest tract loans shall be included with all other real estate loans for the purposes of the aggregate limitations set forth in the first paragraph of Section 24 of the Federal Reserve Act (12 U.S.C. 371), but the aggregate amount of forest tract loans which a bank may have outstanding may not exceed 50 percent of the bank's capital and surplus."

Harvard Holds Production Conference

The Harvard Conference on Forest Production was held at the Harvard Forest, Petersham, Mass., in the two weeks between Oct. 18 and 31. Participants included, in addition to the staff of the forest, a selected group of fifteen men representing the wood-using industries, state and federal forest services, and the forestry schools.

A principal aim of the conference was to bring together a diversified group of practicing foresters in an atmosphere conducive to the study of mutual problems in the general fields of silviculture and management. Discussions and field work were centered on the general theme of "Forestry in Transition," based upon the assumption that American forestry is moving gradually from an era of abundance into one in which the production of wood on the land must be balanced against existing and foreseeable needs. The transition was visualized in terms of adjustments in three areas of the

ATTENDING the Harvard Conference on Forest Production are (left to right) *front row:* James B. Millar, Kimberly-Clark Corp.; John H. Lambert, Massachusetts Dept. of Conservation; Donald F. Strout, International Paper Co.; Edwin L. Giddings, Penobscot Purchasing Co.; Richard V. Ashton, Champion International Co.; Roger P. Sloan, New Hampshire Extension Service; Stanton G. V. Hart, St. Regis Paper Co. *Back row:* Robert W. Wilson, Jr., Northeastern Forest Experiment Station; Peter T. Lannan, Jr., West Virginia Pulp and Paper Co.; John Fedkiw, New York State College of Forestry; Elmer G. Kelso, North, Hollingsworth & Whitney Co.; Sidney Weitzman, Northeastern Forest Experiment Station; Winfred N. Haynes, Union Bag and Paper Corp.; Arthur L. Bennett, Armstrong Forest Co.; Royce O. Cornelius, Weyerhaeuser Timber Co.

field as a whole: in recovery and utilization, in forest management, and in programs and policies.

The work of the conference was divided into four parts: a review of the geographic setting in which the conference was held; a study of a series of case histories in silvicultural research to illustrate problems and methods developed at the Harvard Forest; field excursions outside the Harvard Forest for study of the application of research and research findings to various types of forest operating units, and of adjustments between utilization and the foreseeable supply of materials; and a seminar devoted to discussion of the three areas of adjustment mentioned above. This seminar was attended by a group of sixteen guests representing the country's leadership in the various fields.

Boy Scouts Plan Year of Conservation

The Boy Scouts of America will devote their efforts to conservation during 1954 with a program which they will call the 1954 National Conservation Good Turn. President Eisenhower has endorsed the program, asking all Scouts to "take part in the National Conservation Good Turn, to arouse public recognition of the need for protection and wise management of our soil, water, mineral, forest, grassland, and wildlife resources."

To aid the Scouts in this project, advisory help will be sought from local conservation agencies and technicians, and the work and study of the scout troops will be focused on local projects and needs.

The program will be launched during Wildlife Week, March 21-27, with a meeting of boys and adults interested in scouting, and the conservation good turn. The Outdoor Code for Americans will be used as part of the kick-off activity, and will be promoted by Scout units for the balance of the year. During March, posters will be distributed by Scouts, and from April through September boys will carry out conservation projects in their own localities.

One objective of the Conservation Good Turn will be to get every acre of Scout owned land (about 1/3 million acres) under sound conservation management, and to make Scout camps into outstanding examples of good conservation practices.

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be special demonstrations, held to point up local conservation problems, what the Scout program has done to help solve them, and what can be done further.

Education

Yale Announces Fellowships, Scholarships, and Assistantships

The School of Forestry of Yale University offers instruction leading to the Master of Forestry and Doctor of Forestry degrees. The degree of Doctor of Philosophy is also offered in forestry, but administered by the Yale Graduate School. Men who have had full undergraduate training in forestry may qualify for the master's degree in one academic year of advanced study; others will require longer periods of residence, ranging up to two academic years and one summer term for men with no prior forestry training.

Fellowships and Scholarships

About a dozen fellowship and scholarship awards are made each year. Recipients are required to pay tuition charges ($450 for each academic year) and regular laboratory fees, but no assistance in teaching or research or other service is demanded of them. The following grants are available:

William Henry Sage, Charles Boughton Wood, and *Charles W. Goodyear Fellowships and Scholarships*—These grants include fellowships of $600 to $1,200 each, and scholarships covering the cost of tuition.

Charles S. Chapman Memorial Fellowships in Industrial Forestry (Weyerhaeuser Timber Foundation)—$850 to $1,650—Available to men interested in advanced study and research in the field of industrial forestry.

Union Bag and Paper Company Fellowship—$2,000—Available only to legal residents of states from Texas, Arkansas, Kentucky, and Virginia southward. The recipient is expected to devote part of his program of study to independent research.

Crown Zellerbach Foundation Fellowship — $1,200 — Available only to graduates of institutions in Oregon and Washington.

Prospective candidates for the Ph.D. degree are also eligible to apply for certain fellowships offered by the Graduate School.

Assistantships

A number of assistantships are available in both research and instruction. These may involve either half-time work (and half-time study for a degree) at a monthly stipend during the academic year, or up to 10 or 12 hours of work per week at an hourly rate of pay. Students working on assistantships are required to pay tuition and laboratory fees, but tuition charges are reduced by almost one-half for men studying on a half-time basis.

Further information and application forms may be obtained from the Registrar, Yale School of Forestry, 205 Prospect Street, New Haven 11, Conn. Applications should be filed by March 1.

Government

Repairs to Damaged Watersheds

First aid to denuded watersheds in Southern California caused by the disastrous forest fires of this past summer has been accomplished through action by the Forest Service and cooperating agencies by using contributed emergency funds, materials and manpower.

Emergency treatment consisted of sowing mustard and grass seed by airplanes and helicopters on more than 20,000 acres of rugged mountainous

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terrain. Seeding was done in time so the seed would germinate with the first fall rains—and thus produce a vegetative blanket to stabilize and protect the bare soils.

Areas so treated were: the Sulphur Springs burn on the Angeles National Forest; Arrowhead burn on the San Bernardino Forest; Big Dalton burn on the Los Padres Forest; and the Bronco Flat burn on the Cleveland National Forest.

The magnitude of these seeding operations—extensive as they are, represent only about 18 percent of the area burned by these four fires. Unseeded portions of the burns were classified as not critical enough to warrant emergency seeding.

Virginia Enlists Tree Planters

Along with every hunting and fishing license in Virginia goes a small envelope containing seeds of loblolly, shortleaf, and white pine. The sportsman is requested to plant the seeds according to directions on the envelope: scrape the leaves from a spot the size of a hat, drop the seeds, press them into the ground with the foot. Virginia Forest Service staff members fill the envelopes. The seeds come from state nurseries.

H. L. Mitchell to Forest Products Laboratory

Harold L. Mitchell, director of the Southern Forest Experiment Station, New Orleans, has been appointed chief of the Division of Silvicultural Relations at the U. S. Forest Products Laboratory, Madison, Wis.

Mitchell has been director of the Southern station since the spring of 1950. He previously was director of the Central States Forest Experiment Station, holding this position for five years, during which time four new research centers were established, the Forest Survey was extended to the Central States, and a Forest Utilization Service Unit was set up.

He is a graduate of the University of Minnesota, with a bachelor's degree in forestry, and worked with the Lake States Forest Experiment Station for a year before going to Harvard where he earned his master's, specializing in soils and tree physiology. He worked from 1943 to 1939 at the Black Root Forest, Cornwell-on-the-Hudson, N. Y.; and subsequently worked at the Northeastern Forest Experiment Station, and the Lake City (Fla.) branch of the Southwestern Forest Experiment Station.

Philip Briegleb to Southern Experiment Station

Philip A. Briegleb, director of the Central States Forest and Range Experiment Station, Columbus, O., has been named director of the Southern Experiment Station at New Orleans. Briegleb succeeds Harold A. Mitchell, who is transferring to the Forest Products Laboratory, Madison, Wis.

In his new position, Mr. Briegleb will head Forest Service forest and range research work in Texas, Oklahoma, Arkansas, Louisiana, Mississippi, Alabama, and Tennessee. He has headed forest management research work at the Pacific Northwest Forest and Range Experiment Station, conducted surveys at the Northeastern Station, taught at the University of California Forestry School, and participated in a forestry mission to Chile.

A native of St. Clair, Mo., he studied at Drury College, and at the Universities of Minnesota and Syracuse. He received his bachelor's degree in forestry from Syracuse University in 1929 and his master's degree in 1930.

W. G. McGinnies to Central States Station

William G. McGinnies, director of the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo., for the past nine years, has been named director of the Central States Forest Experiment Station, Columbus, O. He will succeed Philip A. Briegleb, who was transferred to the Southern Station at New Orleans.

McGinnies began his career with the Forest Service in 1921 at the Southwestern Forest and Range Experiment Station at Tucson, Ariz. Subsequently, he worked as forest ecologist in Montana, taught ecology at the University of Arizona, was Soil Conservation Service district manager in Arizona, and forest ecologist at the Southwestern Forest and Range Experiment Sta-

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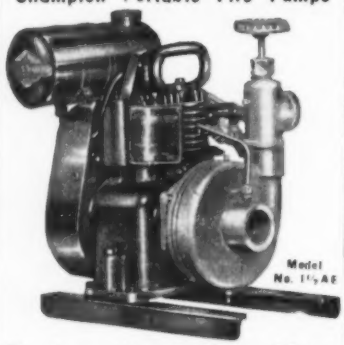

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tion at Tucson. He is an authority on soil-water relationships. During World War II he was director of surveys and investigations for the Emergency Rubber Project in California.

A native of Steamboat Springs, Colo., Dr. McGinnies received his bachelor's degree from the University of Arizona in 1922, and his Ph.D. from the University of Chicago in 1932.

F. R. Longwood to Puerto Rico

Franklin R. Longwood, research forester with the Lake States Forest Experiment Station, Marquette, Mich., was transferred Jan. 1 to the Tropical Forest Experiment Station, Rio Piedras, P. R. In his new position, Mr. Longwood will conduct studies of the suitability and local availability of forest products for Puerto Rico, and their more efficient utilization. He was succeeded by R. M. Godman of the Alaska Forest Research Center, Juneau.

Since May 1, 1949, Mr. Longwood has carried on research in the silviculture and management of northern hardwoods at the Upper Peninsula Experimental Forest near Dukes, Mich. Previously he had assisted in the establishment of the Lower Peninsula Forest Research Center, and from Jan. 1947 to Dec. 1948 was in charge of the Paint Creek Experimental Forest near McGregor, Iowa. He has engaged in farm forestry activities in Iowa, and has been employed in national forests in Michigan, California, Oregon, Washington, and Wyoming.

Longwood is a native of Newaygo, Mich., and has forestry degrees from Michigan State College and Oregon State College.

S.C.S. Heads Named by Benson

Appointments of Donald A. Williams as administrator of the Soil Conservation Service, and Gladwin E. Young as deputy S.C.S. administrator have been confirmed by Secretary of Agriculture Ezra Taft Benson.

Since Nov. 2, effective date of the U.S.D.A. reorganization, Williams has headed S.C.S. as acting administrator. He had been in charge of the Agricultural Conservation Program since Feb. 1953, and before that was assistant chief of the Soil Conservation Service.

Mr. Young has been an assistant to Assistant Secretary of Agriculture J. Earl Coke, in whose office he has been handling flood prevention and watershed work. Prior to his appointment

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to the U.S.D.A. in 1934, he spent several years in land economics research at Purdue Agricultural Experiment Station, and during most of his experience with the department has been in the Bureau of Agricultural Economics. He has been department representative on the Missouri Basin Inter-Agency Committee with headquarters at Lincoln, Neb.

H. C. Storey New Chief of Watershed Research

The Forest Service has assigned Herbert C. Storey, Drexel Hill, Pa., as new chief of its Division of Forest Influences Research.

Storey has been chief of the Division of Forest Influences at the Northeastern Forest Experiment Station, Upper Darby, Pa.

Storey, a native of California, is a graduate of Stanford University, class of 1932, where he majored in geology. He joined the U. S. Forest Service in 1933, and for nearly 10 years carried on watershed studies at the San Dimas Experimental Forest in California. During the war he served in the U. S. Marine Corps.

Mr. Storey joined the Northeastern Forest Experiment Station in 1948, serving first as leader of its Delaware Basin Research Center at Bethlehem, Pa., later as chief of its Division of Forest Influences. He succeeds H. G. Wilm in the Washington office post.

Allied

President Receives Quetico-Superior Committee Report

President Dwight D. Eisenhower has received a report from his Committee for the Quetico-Superior Area. This committee report, while an interim

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one, served to bring the President up to date as to progress, and contained current recommendations from the committee concerning the Quetico-Superior program. It also provided the President with information on the background, purpose and necessity for the program.

The report pointed out that over the years as each threat to the wilderness character of this famous wilderness country developed, there had been some attrition of wilderness values despite the fact that consecutively these threats had been met. Furthermore, it pointed out that if the superb recreational values still remaining are not to be subjected to further threats or attempts at exploitation, an early agreement on common administrative principles for the land use and management of the Quetico-Superior must be reached between Canada and the United States. Possibility of attaining this has been enhanced by efforts of the Canadian Quetico-Superior Committee, of which Honorable Vincent Massey, now Governor General of Canada, was formerly chairman, and the committee of the Northwestern Ontario Associated Chambers of Commerce.

The now famous Quetico-Superior wilderness canoe country comprises the Rainy Lake and Pigeon River watersheds, some 15,000 square miles of territory, containing approximately 15,000 lakes, with interconnecting waterways and portages. Both the Canadian Legion and the American Legion have long been on record for the dedication of this area as an International Peace Memorial Forest as a living memorial to all service men and women of both countries.

The ultimate achievement of the goals of the Quetico-Superior program and its dedication under a mutual management understanding, could serve as an example, for world wide attention, of international cooperation and friendship.

Douglas-Fir Soils Committee Meets

The Forest Soils Committee of the Douglas-fir Region met for its fall meeting at Oregon State College Dec. 11 and 12. George Schroeder, forester for Crown Zellerbach Corporation, chairman of the committee, presided over both sessions.

Dr. S. P. Gessel, who is secretary of the committee, reported that numerous requests had been received from both U. S. and foreign sources for the Analytical Procedures Manual, recently published by the committee and also for the Proceedings of the Forest Soils Symposium held at Seattle last March. Drs. Gessel and C. T. Youngberg reported on the annual Soil Science Society of America meetings which they had recently attended and participated in.

There were two main subjects for consideration. The first was a progress report by Warren Starr who is chairman of a sub-committee that is compiling a list of research needs. The list, when completed, will be circulated to all forest land management agencies in the Douglas-fir region. The need for basic research to aid in the solving of applied research problems will be stressed. There is increasing interest by various agencies in furthering forest soils research. The Oregon Board of Forestry is currently financing a graduate research assistantship at Oregon State College and the Bureau of Land Management has allocated funds for a project dealing with the ecological relationships involved in the use of mustard as a nurse crop and a soil stabilizer in connection with the regeneration of Douglas-fir on burned over lands. Rayonier, Inc., is also making possible some forest soils research work by a graduate student from the University of Washington who is also a member of their forestry staff. It is hoped that the research needs outlined will point up to forest land managing agencies and industries the opportu-

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nity of solving some of the problems facing them through basic forest soils research.

A second item to be considered was further planning for a forest soils manual and textbook for the Douglas-fir region. A preliminary outline was discussed and suggestions for improvement were offered. Assignments for various sections of the manual have been made. An effort is being made to make the manual as informative as possible without making it too theoretical. It is hoped that it will be a useful tool for the practicing forester.

The next meeting of the committee will be held at the College of Forestry, University of Washington, sometime in March. In conjunction with the regular committee meeting an open meeting, to which foresters as well as any other interested persons are invited, will be held to summarize and evaluate progress in forest soils research in relation to its application to forest land management.

Midwestern Shade Tree Conference

The 9th annual meeting of the Midwestern Chapter of the National Shade Tree Conference will be held Feb. 17-19, at the LaSalle Hotel, Chicago, Ill. Organized to encourage the planting of more shade trees, and to promote within the trade better observance of approved arboricultural practices, membership is composed of commercial arborists, city foresters, park superintendents, nurserymen, educators, research scientists and others interested in the propagation and care of trees and ornamental shrubs.

The convention is open to all who wish to attend.

The program is directed toward discussion of problems primarily of concern to arborists in the midwest, but included also are topics of general interest to those who care for trees in any section of the country.

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Irrigation Development and Public Water Policy

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NEW, comprehensive examination of economic and social aspects of irrigated agriculture and public water policy in the United States. Describes the planning, financing, organization, and operation of irrigation projects. Fully discusses the important considerations that are essential to sound and farsighted irrigation policy on the local, regional, and national levels, and assesses the role of irrigation in river basin development and in the nation's agricultural production. *336 pp., 19 ills.* **$6.50**

Resources and the American Dream

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THIS realistic report by a foremost conservationist comes to grips with the fundamental problem of our dwindling natural resources. A sober warning to the "Cornucopians," the book shows how consumption of raw materials can and *must* be brought into balance with supply if our culture is to endure. *"A clear, honest, and extremely important book. I think Ordway has gone right to the heart of the problem which is basic to modern civilization."*— PAUL B. SEARS, Chairman, Conservation Program, Yale University. **$2**

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Southern Pine Association Appoints Cothren as Forester

Virgil W. Cothren, an employe of the Southern Pine Association since 1950, has been appointed forester for the association to replace W. C. Hammerle who resigned to accept a position with the Forest Farmers Association Cooperative, Atlanta, Ga.

Mr. Cothren is a graduate of Louisiana State University, with a B.S.F. in forest management, and Yale University with an M.F. degree. He served with the Texas Forest Service before becoming associated with S.P.A. as a field representative in the Trade Promotion Department.

P. W. Wright Heads F.F.A. Membership Work

Paul W. Wright, industrial forester for the Atlantic Coast Line Railroad, Wilmington, N. C., is the new chairman of the Membership Committee of the Forest Farmers Association of Atlanta, Ga. Mr. Wright's appointment was announced by President J. V. Whitfield at a recent meeting of the association's board of directors.

He succeeds R. Vance Miles, Jr., forestry manager, Gulf States Paper Corporation, Tuscaloosa, Ala., who has been membership chairman since 1952.

In appointing Mr. Wright, President Whitfield noted the advances made under Mr. Miles' chairmanship and stated that even greater emphasis is planned on the participation of more small landowners during the coming year.

A.F.P.I. Awards to 4-H Club Forestry Winners

Skill at growing timber crops won college scholarships for four 4-H Club boys from Arkansas, Connecticut, Ohio, and Wisconsin.

Each boy received a $300 scholarship at the recent 4-H Club congress in Chicago from American Forest Products Industries, Inc., national donor of the forestry awards. James C. McClellan, chief forester for A.F.P.I., presented the scholarships.

Winners were Delmar Tyree, 18, Prescott, Ark.; John E. Habbard, 17, East Woodstock, Conn.; Anthony Gwirtz, 20, Shelby, Ohio, and Lynn Lowman, 16, Augusta, Wis.

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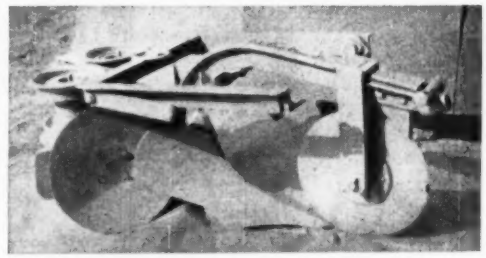

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H. B. McKean Joins Potlatch

Herbert B. McKean, associate director of research for the Timber Engineering Company, Washington, D. C., is to assume the duties of director of research for Potlatch Forests, Inc. McKean will be located in Lewiston, Idaho, and is to undertake his new duties on March 1. He is associate editor of the JOURNAL.

Frost Makes Ownership Study For C. of C.

A study of federal government ownership of forest land in East Texas has been announced by Hubert M. Harrison, general manager of the East Texas Chamber of Commerce.

The chamber has obtained the services of S. L. Frost of Falls Church, Va., to make the study.

Frost formerly spent 13 years in Texas with federal and state forest services. In 1933 and 1934 he assisted in the appraisal of much of the timberland now in national forests in East Texas.

Shortly before leaving the Texas Forest Service in 1948 he recommended plans for reorganizing the department. He was formerly executive director of the American Forestry Association in Washington.

Harrison states that the Chamber wishes to make the study as fair and impartial as possible and that they have asked Frost to get all the facts he can from private and public sources and to present his own recommendations to the special committee.

Cooperation has been requested of the Secretary of Agriculture, U. S. Forest Service, the Texas Forest Service, and the timber industries.

Plans call for completion of the study by April 1.

A. F. Muschler Joins Hines Lumber Co.

Arthur F. Muschler, formerly on the staff of the Yale School of Forestry, has joined the engineering division of the Edward Hines Lumber Company.

Muschler is a graduate of Michigan State College and holds a master's degree in forestry from Yale University. He is completing requirements for the Ph.D. from the University of Michigan.

While at Yale, he supervised laboratory phases of the tropical woods

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Box A, Journal of Forestry, Mills Building, Washington 6, D. C.

Graduate Michigan College of Mining and Technology, forest production, desires position as assistant in forest management work or related field. Prefer in or near Lake States. Six years woods experience, two years forest products inspection work. Age 31, married, two children. Hard working, willing.

Box S, Journal of Forestry, Mills Building, Washington 6, D. C.

Forester, B.S. West Virginia Univ. 1950, graduate of New York State Ranger School, 1940; veteran of World War II, desires job in forestry or related field. Some experience in forest management and wood preservation. Married, 3 children.

Box T, Journal of Forestry, Mills Building, Washington 6, D. C.

Forester-surveyor, 5 years experience in logging with companies in the Pacific Northwest and 8 years experience in general forestry with the U. S. Forest Service in the Lake States, desires position in forest management with a large logging or pulp company. BSF degree and 20 years experience in supervising large groups of men. Will furnish references and report for an interview upon request.

Box U, Journal of Forestry, Mills Building, Washington 6, D. C.

Forester five years experience in logging and eight years experience in general forestry with the U. S. Forest Service desires employment with a mahogany or balsa company in Latin America. Other positions relative to forestry will be considered. BSF degree and good working knowledge of Spanish, plus two years experience in the tropics. Will report for interview upon request.

Box V, Journal of Forestry, Mills Building, Washington 6, D. C.

Forester, B.S.F. New York State College of Forestry, single, 27. 2 years experience in pulpwood procurement; mapping, cruising, road location. 1 year with federal agency in timber sale layouts, administration of timber sales, reforestation and fire protection. Desire position in procurement or timber management work, preferably in the east or south.

Box W, Journal of Forestry, Mills Building, Washington 6, D. C.

research program sponsored by the Navy Department.

Caterpillar Tractor Company Anniversary

Caterpillar Tractor Co., Peoria, Ill. will commemorate during 1954 the 50th anniversary of the world's first practical track-type tractor. The successful testing of the first practical crawler was made on Nov. 24, 1904 in Stockton, Calif., by the Holt Manufacturing Company, one of Caterpillar's parent companies. It was the Holt Company which originated the trademark, "Caterpillar" at about the same time it made its first crawler. This Holt unit was the forefather to approximately 340,000 track-type tractors of all makes which are now working in many fields, exclusive of the military, in the United States alone.

Plans for this commemorative program year have been announced by W. K. Cox, Caterpillar sales promotion manager. He said, "We believe 1954 is an important milepost because the crawler has played such an important role in the development of our nation in both peace and war. During this half century it has been instrumental in the progress made in construction, logging, mining, oil, agriculture, and many other fields which have had a great effect on all of us in one way or another."

Electric Bar Groove Grinder Available

Oregon Bar Groove Grinder, a new electrically driven tool to be used by filing shops and chain saw dealers in regrooving and reconditioning saw bars, has been announced by Oregon Saw Chain Corporation, 8816 S. E. 17th Avenue, Portland 2, Ore., saw chain and bar specialty firm.

The new tool operates from any 110-115 volt AC current outlet and will widen and deepen bar grooves on any make of saw bar to fit .050 and .120 gauge chain. Only four square feet of bench space are required to accommodate the grinder, which is housed in a steel casing mounting a surface plate which may be hand adjusted up or down precisely to center the grinding wheel in the bar groove.

Grinding is accomplished with 8-inch resinoid bond abrasive slotting wheels specially manufactured for use on the machine, and available in six different thicknesses. The electric motor is a heavy duty capacitator type and is equipped with a thermal overload protector. Total shipping weight of the new grinder is 116 pounds. Cost is $110 f.o.b. factory.

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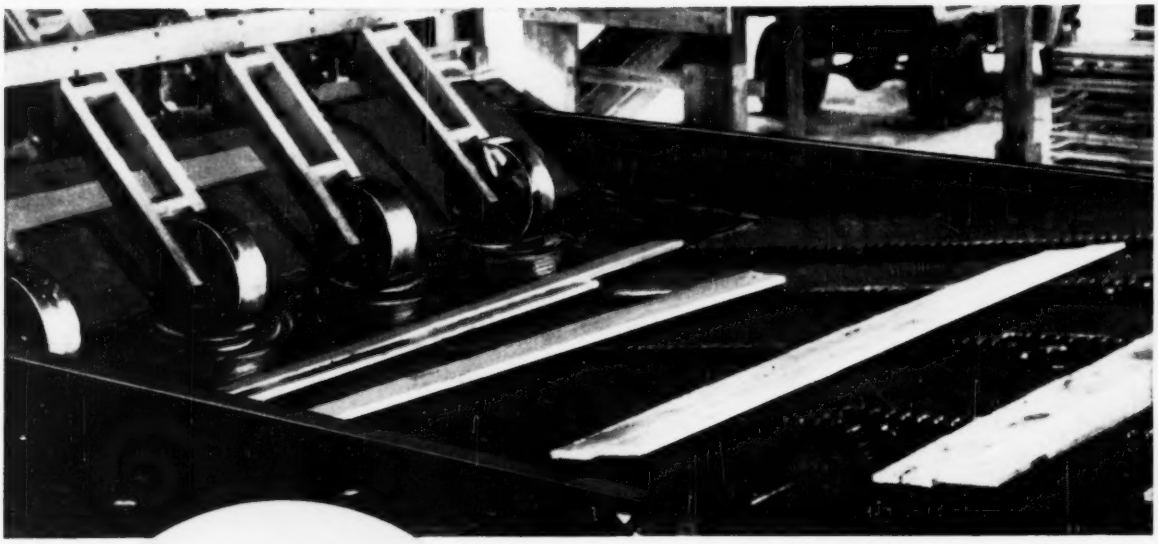

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